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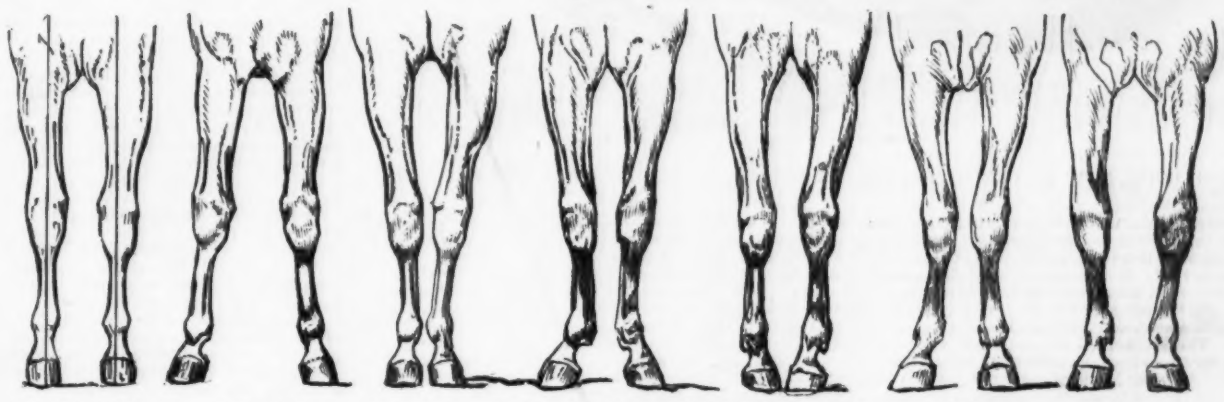
HORSES' LEGS.

By Richard Hugh Hilhouse.

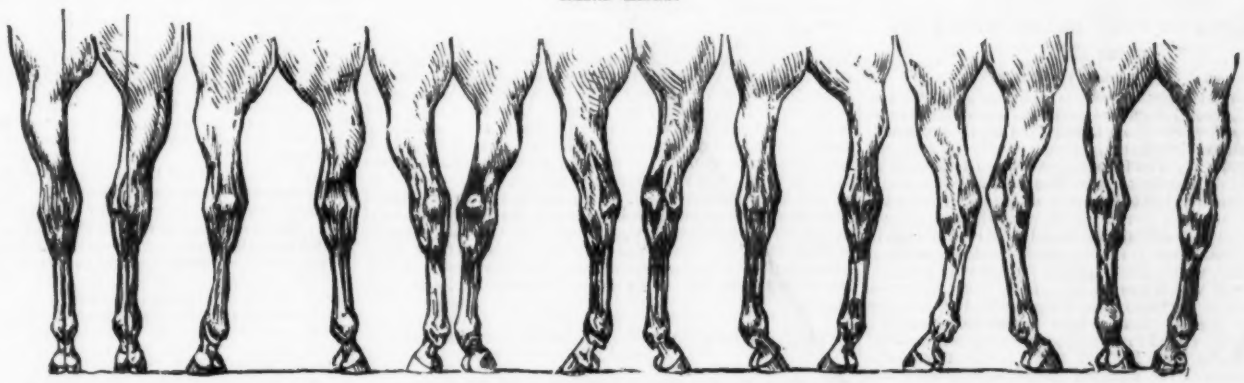
In my opinion the bar to profit is hereditary malformation and false position of the limbs. Conformation, however fascinating, is of little value unless the subject steps and goes. To obtain this the incidence of weight must be truly or evenly distributed. Brilliant action is derivable from courage and the pronounced development of bony structure, securing ample leverage to the tendons passing over them and attachment to the ligaments belonging to them, *e. g.*, elbow bone at the back of the knee, also back of the fetlock; stifle, point of the hock, and bones at the back of the fetlock joint. The happy alliance of the foregoing produces not only the grand mover, but that true, neat action which wears well and does not tire. The engraver has admirably produced the correct pose, together with the more prominent faults in position, so frequently met with in combination in one and the same horse.



FORE LEGS.

1. Standing straight and true. 2. Too wide. 3. Too close in front. 4. Duck-footed, with twisted cannons outwards. 5. Twisted cannons inwards, and pin-toed. 6. Calf-kneed. 7. Knee too open.

HIND LEGS.



1. Standing straight and correctly. 2. Too wide. 3. Too close behind. 4. Duck-footed behind. 5. Bow-legged and pin-toed 6. Cow hock. 7 Too open.

With this key, misshaped legs, misplaced feet, or bad action, will be noted, and either counteracted or wholly avoided when mating, because these deviations are the source of blemish and inflammation at the weakest points, *e. g.*, splints, spavins, thoropins, curbs, brushed ankles, wind galls, sprung tendon; also bad action all round, *e. g.*, cat action, darting, fighting, dishing, winding of the toe, brushing and its converse, open action, or straddling. All these depreciate value, notwithstanding elegance and strength of make in the top line while standing.

Fore Legs.—No. 1: A line let fall from the point of the shoulder should reach the ground at the point of the toe; if the foot is to the rear of this the equilibrium is lost; action clambering and unsafe. If this line falls "without," the legs are too close at the point of departure; if it falls "within," the legs are too wide apart.

Hind Legs.—No. 1 represents the horse standing correctly, with his limbs well outside the body. A line (imaginary) let fall from the point of the quarter bisecting the gaskins, point of the hock, back of the fetlock and heel, or a line let fall from the stifle, should reach the ground barely in front of the hind toe for hunting and draught classes; this, with muscle, gives force in action. When the toes recede, as in racing stock, the hocks setting out beyond our line, No. 1, this is a speedy formation. The distance from the stifle line and the toe may vary 4 to 8 inches when standing at ease on the ground. The line may also be used in profile for adjudicating position and length of pasterns, for—

> "Upright he walks, on pasterns fine, not straight,
> His motion easy, prancing in his gait."

Thanking Mr. Thomas Bartlett, Paris, for the diagrams, I hope the above will benefit my brother farmers and our own tenants. I trust the diagrams will meet with a wide circulation among breeders; their study cannot fail to profit them.—*Agricultural Gazette.*

SULPHURET OF CARBON FOR KILLING INSECTS.

Dr. J. M. Eder proposes the use of a sulphuret of carbon bottle for killing insects in place of the cyanide of potassium bottle which is now so commonly employed. He describes it as particularly well adapted for beetles. The apparatus recommended is a wide-mouthed bottle, well corked, containing a few fragments of blotting paper. When an insect is captured and put into the bottle it is to be followed by three or four drops of sulphuret of carbon (a supply of which must be carried in a small store-bottle), when the animal is almost instantaneously killed by the action of the vapor produced. The largest beetles die in a few seconds. With careful corking after the introduction of each capture, the three or four drops of sulphuret of carbon will continue their action for an hour or two, but as soon as the insects begin to die slowly, a fresh supply of the reagent must be added. The great advantage is that owing to the rapidity with which sulphuret of carbon evaporates, the interior of the vessel is always perfectly dry, so that no insect, however delicate, can be injured by it. Solution of cyanide of potassium is said to be slower in its action, and to have the disadvantage of introducing moisture, and of giving origin to carbonate of potash, a hygroscopic salt.—*Verhandl. Zool. bot. Gesellsch.*

TRICHINÆ IN THE HIPPOPOTAMUS.

M. E. Haeckel announces the occurrence of *trichinæ* in great abundance in a young hippopotamus received from Egypt, which lived for about four months in the Zoological Gardens at Marseilles. The animal suffered from skin disease, taking the form of great suppurating boils, during the whole of its residence at Marseilles. On examination these sores were found to have penetrated the skin, and to lead to great cysts filled with pus in the subcutaneous tissue. It was after the greater part of the flesh had been thrown away that M. Haeckel detected the *trichinæ* in the muscles surrounding one of the cysts which he had kept, and he was unable to ascertain whether the trichinosis and the external symptoms were in any way correlated. The discovery of the parasite in this great pachyderm is of interest.—*Comptes Rendus.*

The discovery of archæological remains on the banks of the Trubesh River, in Poltava, Russia, is of great scientific interest. A large number of stone arrows and knives, besides pieces of coal, bones, fragments of earthenware, and bronze implements, have been dug up from beneath the recent deposits of sand.

THE VIPERS OF GABOON.

The western part of tropical and intertropical Africa seems to be the country *par excellence* of those dreaded vipers embraced in the family called by naturalists *Elapidæ*, and which are clearly distinguished by the extreme flatness of the head and its triangular shape, and the direction of the nostrils, which open vertically and not laterally. Nearly all the species of the genus, in fact, are found in this region or in southern Africa, although the Mauritanic viper lives much more to the north and is met with in the south of Algeria.

Among the vipers of the warmer regions of Africa, two may serve to more particularly interest us. Through the zeal of Dr. Bestion, of the French navy, these two interesting serpents have just been received by the menagerie of the Museum of Natural History at Paris. They are known as the rhinoceros and horned nose vipers, and came from Gaboon.

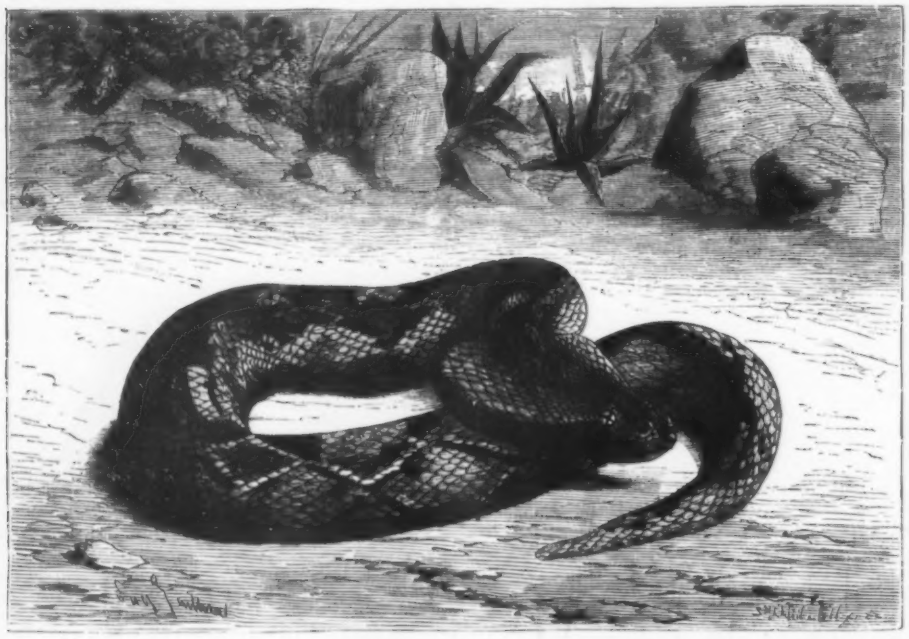
The rhinoceros viper, or viper of Gaboon, is a snake which sometimes attains a length of nearly four feet. Its head is large and flat, and made very distinct from the neck by the prominence of the angles of the jaws; its snout is short and obtuse, and projects somewhat between the closely situated nostrils, and is covered with two large strongly ridged scales. Its eyes are directed obliquely upward. Its general color is a velvety reddish brown, heightened on the flanks by large blotches, which are surrounded by greenish brown lines bordered with white. In the middle of the back these blotches assume the form of elongated parallelograms. The temples are covered with a large triangular brown spot; the top of the head is of a brick-red color; and from the end of the snout to the neck extends a black stripe, and on each side of this is a blotch of the same color. According to Dr. Savage, who has resided for many years at Gaboon, this species of viper is slow and lazy in its movements, flying from man unless attacked. It lives in the highlands as well as the lowlands near the coast, and feeds on birds, rats, reptiles, and fish of marshy places. It is exceedingly venomous, and its bite may be said to be always fatal. The presence of the snake is recognized by a very peculiar noise that it makes, and which sounds like a suppressed groan, followed by a hissing or blowing sound. When this is heard the natives take to their heels, for the reptile is then on the defensive. In striking it flattens its head and its body, opens its jaws widely, its fangs directed forward, and then darts forward from its powerful tail as a fulcrum. After a viper bite there is acute pain in the wound, with livid swelling, faintness, quick and irregular pulse, nausea and vomiting, and cold sweats.

The six horned viper, *Cerastes nasicornis*, has the same habits. This species, although closely resembling, differs from the other more especially in having at the end of the

snout, between the nostrils, six soft and scaly horns or spines, which give it a very malignant look. Its general color is a greenish brown, relieved along the back by elongated greenish blotches, surrounded with yellow and crossed through the middle by a line of the same color. Its head is marked with a brown triangular spot bordered with yellow.

The most deadly serpent of South Africa is the short-tailed viper or puff adder (*Vipera arietans*) of the Cape of Good Hope; it is about three feet long and two inches in diameter, brown, with an angular cross band, a pale line behind it, and a red band across the eyes.

The horned viper (*Cerastes hasselquistii*) of northern Africa,



VIPER OF GABOON, NOW IN THE MENAGERIE OF REPTILES AT THE JARDIN DES PLANTES.

Arabia, and western Asia, was well known to the ancients; it is the serpent represented on the Egyptian monuments, and has been supposed to have been the asp by which Cleopatra destroyed herself. It is indolent in habit, remaining buried in the hot sand till aroused by hunger or attacked, when it is very active, springing two or three feet; when it bites it retains a firm hold, and makes no haste to escape like most serpents. The six horned (*C. nasicornis*) viper mentioned above is supposed by some naturalists to be a variety of this species. The viper is one of the reptiles which have a distribution very far north, and the furthest of the snakes. It is popularly believed to take its young when in danger into its throat. Although some have declared this impossible, there seems to be good reason for believing it true.

THE GEOLOGY OF PORT HENRY, NEW YORK.

T. STERRY HUNT.

[Abstract.]

PORT HENRY, in Essex County, is well known as a locality where the Laurentian gneisses, with their associated limestones and iron ores, rise from beneath the nearly horizontal paleozoic strata of the Champlain valley. The gneiss just above the Port Henry iron furnace presents alternations of lighter feldspathic and darker hornblendic beds with others highly quartzose, and includes layers of a sulphurous magnetite (which are, however, insignificant when compared with the great deposit of this ore mined at Mount Moriah in the vicinity). Near by is seen a considerable breadth of white crystalline, somewhat graphitic limestone, along the eastern border of which are three smaller beds of two or three feet, each of the same rock, interstratified with layers of crumbling gneiss. Half a mile southward, near the town, a quarry is opened in a more coarsely crystalline limestone, in which, as seen in 1877, were inclosed irregular masses and layers of the adjacent gneiss, sometimes transversely broken, but scarcely separated, and from two inches or more in thickness, though sometimes much larger. The limestone was marked by lighter and darker bands containing more or less graphite and pyrites, and in parts held coarsely crystalline sphene and green pyroxene in layers. We have here one of those cases which led Emmons and Mather to assert the eruptive character of these limestones, and it is probably a similar instance which lately led an eminent geologist to describe crystalline limestones in this region as underlying uncomformably the gneisses. The phenomenon, in the writer's opinion, is one which he has elsewhere described at length, namely, the occurrence of great calcareous veinstones which hold the characteristic minerals of the adjacent interbedded limestones, and like granitic and metalliferous veinstones, have been deposited from solutions in the fissures of the broken gneissic strata, and are not unfrequently brecciated as in the present case. These calcareous masses are not eruptive but endogenous. The Laurentian gneisses abound in similar instances.

A few miles north from Port Henry, the gneiss, with its magnetites, is replaced by the massive bedded labradoritic rocks of the Norian series (the hypersthene rocks of Emmons), with great masses of titanic iron ore, which latter abound near Westport. Prof. Hall has described these rocks as newer and unconformable with the underlying gneiss, which accords with the numerous observations of the relations of these two series made in Canada. The Norian rocks are well displayed along the railway between Westport and Port Kent, where a nearly continuous cutting of about five miles through them, around Willsborough Bay, affords a good opportunity for their study. Prof. Leeds has lately made a valuable series of chemical and microscopical studies of the Norian rocks of this region.

The Potsdam sandstone, the basal member of the overlying paleozoic series, is well seen in a railway cutting at Port Henry. The lower beds are massive and compact, dark bluish or iron-gray, with lighter bands and thin, blackish shaly layers. Dipping gently to the northward they become overlaid by the higher beds of the formation, which are light gray and porous, and composed apparently of agglutinated silicious grains, as if concreted from solution, as long ago remarked by Prof. Hall for the similar strata of Iowa. Some of these upper layers have irregular cavities, as if from the disappearance of organic remains, and others exhibit numerous tubular marking, differing alike from the *Scolithus linearis* of the Primal sandstone, and the *S. canadensis* of the Potsdam of the Ottawa basin. The markings at Port Henry are small vertical cylindrical cavities, often eight or ten centimeters in length, and about three millimeters in diameter, having a concentric interior tube or cylinder of about two millimeters external, and one internal diameter, and sometimes exhibiting traces of concentric layers. Further study is needed to determine the origin of these markings, which I have elsewhere described.

Above these sandstones are seen massive layers of an impure dark bluish limestone without observed fossils, holding eighteen per cent. of magnesia, and probably representing the so-called calciferous sand rock (which is really an impure dolomite). As seen along the railway, these beds have at first a very gentle dip to the northward, which soon grows steeper until where lost sight of a few hundred feet from the wall of gneiss they dip toward it with an angle of about sixty degrees to the northwest. The almost constant eastward dip of the paleozoic strata on the east side of the Champlain and Hudson valleys, as a result of which the newer seem to pass below the older and more crystalline rocks, is well known. It is easy to conceive that lateral pressure, from the contraction of the earth, acting upon horizontal strata deposited against a barrier of older and resisting rocks, may, according to circumstances, either cause them, by the sliding of their edges, to be raised up and made to dip away from the older rocks (a case frequently met with), or else, the edges remaining fixed, the compressed strata beyond will be upraised in one or more folds (which may even be overturned) so that the proximate portions are made to dip towards the resisting barrier. This condition, as was so well shown by H. D. Rogers, is seen in the Primal and Auroral along the northwest base of the South Mountain in the great Appalachian Valley. We have here apparently, at Port Henry, an example on a small scale of the same phenomenon, on the opposite side of a valley, and against the southeastern base of an ancient barrier of Laurentian gneiss.

THE VOLCANO OF KILAUEA, SANDWICH ISLANDS.

ON A RECENT SILENT DISCHARGE OF KILAUEA.

By DR. TITUS COAN.

IN a letter to J. D. Dana, dated Honolulu, Hawaii, June 20, 1879, Dr. Coan writes:

You may have heard ere this that Kilauea has again disgorged a fiery flood and retired within her subterranean chambers. A little over ten years had elapsed, during which time the repairs of the eruption of 1868 were going on, until the emptied "South Lake" was replenished, "heaped up and running over;" when, without premonition, an unknown subterranean passage was opened and the vast fiery basin was emptied, as in 1868.* But this disgorgement was hidden and peculiar. The lake of fusion, which had been raised, by its self-made surrounding wall, nearly to the height of the outer rim of the crater, quietly subsided several hundred feet, ceased its boiling and nearly extinguished its fires, leaving nothing but a vast smoking caldron.

You may remember that, after the grand eruption of 1868, I succeeded in scrambling down into the bottom of this evacuated pit, about 400 feet, and measuring across its bottom a distance of one mile minus about 100 feet. This awful caldron had only a few days before been filled to overflowing with boiling lava, raging, rolling in fiery waves from side to side of the glowing pit, dashing against its heated walls, and throwing up its sheets and spouts of liquid fire 20, 40, and 50 feet into the air, while the surrounding deposits of solidified scoria formed a smoking mountain. Out of the northern and northwest sides of this accumulated mass of volcanic product streams of liquid lava burst from time to time, flowing down into the central region of the crater, and thus raising it, foot by foot, for months and years. Added to these subaerial outflows there were oft-repeated, upward, or vertical gushings of lava through seams and crevices; and thus, by these twofold actions, the great central depression, caused by the subsidence of a very large area of this part of the crater, was gradually filled up.

One feature of this last eruption of Kilauea is the fact that the great molten lake was drawn off subterraneously, giving no warning of its movements, and leaving no visible indication of its pathway, or of the place of its final deposit. Other eruptions have blazed their way upon the surface to the sea, or while on their subterranean way have rent the superincumbent beds, throwing out jets of steam or of sulphurous gases, with here and there small patches or broad areas of lava. But as yet no surface marks of this kind reveal the silent, solemn course of this burning river. One theory is that it flowed deep in subterranean fissures, and finally disembogued far out at sea. Our ocean was much disturbed during these days, and we had what might be called a tidal wave of moderate magnitude. For some time after this eruption, Kilauea lay with scarcely any visible fire, and only here and there puffs of white steam and jets of escaping gases. All visitors were for several weeks greatly disappointed, and some were inclined to think that the vivid descriptions of former visitors were fabulous; but later advices report the old goddess as arousing from her slumbers, stirring up the coals, lighting her lamps, and sending out fiery glances from her red eye-balls. So the old process of replenishment has begun, and after another decade another disgorgement may take place.

Mokuaweoweo, the summit crater, has been quiet for a long time. Moderate earthquakes occasionally admonish us that nothing earthly is stable; our aerial thunders have never been more sublime than during March, April, and May.—*American Journal of Science.*

* Mr. C an does not mention the precise time of this eruption; but, from some statements in the Sandwich Island papers, it probably took place in April last. The "South Lake" referred to is in the bottom of Kilauea; and, though large, is small compared with the area of the bottom of the pit, the longest diameter of which is 3½ miles. J. D. D.

THE HUMAN RACE AT LEAST TWO HUNDRED THOUSAND YEARS OLD.

WE published recently an interesting article by Rev. Mr. Templin, from the Kansas City *Review*, on the Antiquity of Man, referring to which Prof. B. F. Mudge, of Kansas, now writes to the *Review* as follows:

We were much interested with the article on the Antiquity of Man, by the Rev. J. L. Templin. He has very clearly and fairly stated the facts in the case, though we think he has left the question of the age of our race, in years, too indefinite.

We agree with him (and Dana) that man was on earth "at the close of the glacial epoch, that he witnessed the retreat of the glaciers from Central Europe," etc., etc. After the glacial epoch, geologists fix three distinct epochs, viz., the Champlain, terrace and delta, which have been considered of nearly equal lengths. The question then arises, Have we no evidence to show the length of either of these periods?

There are facts which circumstantially give us a near approximation of the age of each, but they are nearly all based on considerations which only an expert geologist can appreciate. There are, however, in the delta period of the Mississippi, proofs which will give a very close approximation, in years, to the length of this epoch.

Various estimates have formerly been made for the time of the delta period, with varied results, Lyell and others placing it at least at 100,000 years, and others making it less. Further researches, extensively made, have confirmed Lyell's estimate. The most reliable evidence is as follows: For a distance of about two hundred miles of the delta are seen distinct forest growths of large trees, one over the other, with interspaces of sand; showing distinct periods of the entire destruction of the forests; and after burial, again a new generation of trees over the others. There are ten of these distinct forest growths, which have begun and ended, one after the other. The outstretched, undisturbed position of the roots of the trees, as well as the other conditions of the deposits, show that they were not washed in, but grew on the spot.

Now if we can fix the time occupied by the life of these trees, we can give, at least, an approximate result. Fortunately the data are clear and can be studied by any person of ordinary intelligence. The trees in question are the bald cypress (*Taxodium*) of the Southern States, one of the largest and longest of life of the world's trees. Specimens cut down in the present age are known to be from 5,000 to 7,000 years old. Humboldt saw one in Mexico of extremely large size, which he estimated—from counting the rings of smaller trees of the same species—to be eight thousand (8,000) years old.

Such are the trees found in these old, buried forests of the delta of the Mississippi. Some of the old trunks were over twenty-five feet in diameter. One contained over 5,700 annual rings. In many instances these huge trees have grown over the stumps or fallen trunks of others equally large. Such instances occur in all, or nearly all, of the ten forest beds. Dr. Dowler, one of the best physicians and scientists of New Orleans, saw such instances in many places, and concluded that each of the ten forest growths contained, on the average, two such trees of 5,000 years each, living in succession. This gives to each forest a period of 10,000 years. Ten such periods give 100,000 years, without considering the time covered by the intervals between the ending of one forest and the beginning of another. The thickness of the intervening sand shows that this interval was not, in most cases, a short one.

Such evidence would be received in any court of law as sound and satisfactory, where common sense evidence is used. We do not see how such proof is to be discarded when applied to the antiquity of our race. If the antiquity of the mastodon was in discussion no one would doubt it. Human bones have been found in the fifth forest bed, and stone implements still lower. As Rev. Mr. Templin has stated, there is satisfactory evidence that man lived in the Champlain epoch. But the terrace epoch, or the greater part of it, intervenes between the Champlain and delta epochs, thus adding to my 100,000 years. If only as much time is given to both those epochs combined as to the delta period, 200,000 years is the total result.

There are other evidences in Europe, generally clear to the geologist, which sustain this long time for the antiquity of man.

IT is stated that the successful borings for water in Frame County, South Australia, promise to render a large district, formerly almost destitute of water, highly valuable for agricultural or pastoral purposes. One artesian well, 400 miles north of Adelaide, sunk to the depth of 370 feet, yields 10,000 gallons of excellent water a day. Much of the arid and inhospitable region between the coast and the rich lands which have been discovered in the interior of the continent is expected to be reclaimed by a systematic tapping of the springs supposed to exist beneath.

THE ICE CAVERN OF DOBSCHAU.

MR. W. BEZANT LOWE, while on a tour in Hungary last summer, had an opportunity of visiting an ice cavern near the town of Dobschau. The person who discovered it acted as guide, and desired Mr. Lowe to make the cavern known to the public. With the latter object in view he has prepared the following short description:

The cavern is situated to the northwest of Dobschau, and is reached by means of a narrow winding limestone valley, the "Stracenaer Thal." Its general direction is from west to east in the interior of a mountain whose slope faces the north; the descent into it varies from oblique to precipitous, the very narrow entrance being situated at the highest point of the cavern. The ice consists of innumerable layers frozen together, one upon the other, and assuming various fantastic shapes. The total surface of the ice and rock is 8,874 square meters, that of the former being 7,171 sq. met., and of the latter 1,703 sq. met. The mass of the ice amounts to 125,000 cubic meters. The cavern is divided into two parts—an upper and a lower story. The former is reached directly after leaving the entrance; its floor is formed of ice, and its roof and walls of limestone. It is partially divided into two unequal chambers by a curtain of rock descending from the roof. The small saloon is not situated at the same level as the large one. In the great saloon are three ice pillars (see accompanying figure), and down the cylindrical cavity of one pillar there is a continuous though small flow of water. In addition, there are numerous other ice ornaments which have received fanciful names. The eastern end of the saloon is contracted into a very narrow corner; and at this point there has been a land-slide corresponding to a crater-shaped depression in the slope of the Duosa Mountain, in which the cavern is situated. In the small saloon to the right of the entrance is seen a waterfall composed entirely of ice.

THE ICE CAVERN OF DOBSCHAU. (Interior view of the great saloon.)

The lower story consists of a corridor, 200 meters in length, and in the left wing of which is a magnificent ice structure called the grotto. The mean temperature of the air in the cavern during the year is—0·86° C. This permanent low temperature is due to the height and northern aspect of the cavern, as well as to its narrow opening and contracted exit canal, and to its flow gradually sloping inwards. As a result of this the water is converted into ice, and the permanence of the latter thus insured.

NORDENSKJOLD IN THE ARCTIC.

ACCORDING to the *Nya Dayligt Allehanda*, a journal published at Stockholm, a private letter was received in the latter part of June overland from Lieutenant Palander, the commander of the Vega, stating that all was well on board of the steamer. The mouth of the Lena river was passed on the 27th of August last. In the beginning everything was favorable, although the Arctic explorers had to contend with ice and shallow water. They succeeded in reaching Cape Jakan, but here for three days further progress was stopped. That point was left on the 11th of September, and after many difficulties they arrived, on the 13th, at Cape North, where they were shut up in ice until the 18th. After that the Arctic voyagers were only able now and then to advance, owing to the compact ice. On the 28th of September they arrived at their present position in latitude 67 degrees 6 minutes north, and longitude 173 degrees 30 minutes west. Had that point been reached two days earlier, the steamer would have been able to pass through Behring Strait.

The Vega is not anchored in any harbor, but near a very shallow sand beach, and moored to solid ice. All hands are well, and provisions plenty; coal sufficient for a 2,000-mile cruise. One or two villages of Tschutsches had been passed. These natives were believed to originate from Greenland, and, judging from their appearance, appeared to be related to the Esquimaux. Their complexion is brownish yellow, hair and eyes jet black. They are dressed in reindeer robes, dwell in tents of hides, and live on the fat of the seal. They are, moreover, friendly disposed and accommodating. The women's faces are tattooed, the men's not. Their language is very difficult to understand, but the Swedish explorers have nevertheless acquired it and compiled a Swedish-Tschutschian dictionary, embracing over three hundred words. Three camps of Tschutsches are on the shore in the vicinity of the Vega's anchorage. During September the temperature was never below three degrees, and five degrees Celsius was the coldest at any time. On the 21st December, the darkest day of the year, the sun was still above the horizon. The letters had been sent from the Vega by a visiting native chief residing in the neighborhood of Anadyrsk. The Polar explorers calculated to extricate themselves by the 1st of July, and to reach Japan by the 15th of August.

The following is an extract from the famous Arctic explorer's last letter to his family: "On board the Vega, icebound on the north coast of Siberia, just east of Koljuschin Bay, latitude 67 deg. 7 min., longitude 173 deg. 15 min. west of Greenwich, the 6th of October, 1878.—Since I last wrote from the mouth of the Lena River the Vega has pressed forward, though with no little difficulty, to the vicinity of Behring Strait—*i. e.*, to a part of the Polar Sea which is every year visited by whalers from the Pacific Ocean and trading vessels belonging to the American Alaska Company. These vessels have frequently left these waters as late as the middle of October. As a result from the northern and northwesterly winds blowing in these regions during the whole of September, it appears, however, that this year a most unfavorable condition of the ice has prevailed in the Polar Sea, near Behring Strait. The ice-free channel which in the proximity of the coast facilitated our progress as far as beyond the mouth of the Lena River, ended at the Basanow Islands, which we passed on the 3d of September. Since then we have gone forward through dense masses of floating ice so slowly that we did not reach the eastern coast of Koljuschin Bay until the 27th of September.

"The night of the 28th the ocean was covered, between the glacial fragments, with new-formed ice, so that we were forced to abandon further attempts to proceed, but temporarily lay to alongside some large floes of solid ice about half a mile from the beach. Three days later we were able to walk ashore on the new formed ice. Consequently everything is as satisfactory as possible in the event of our being obliged to spend the winter here. The coast is inhabited by Tschutsches, with whom we are in communication on most friendly terms, although, as these natives do not understand or speak Russian, we have some difficulty in making ourselves mutually intelligible. Lieutenant Nordgvist, however, has made a good beginning in learning their language. They declare unanimously that the ice will again break up; but in the event their prediction should fail I send this letter by a Tschutsch chief, who happened to visit the village near our place of anchorage. It is most uncertain whether we will succeed in making him understand the meaning of the papers we hand him, and it is doubtful whether they ever will reach their destination. All hands are well, the vessel in perfect condition, and the supplies of coal and provisions abundant. The Tschutsch chief, who has appointed me to be the *Isprawenik* in Ochotsk, was pulled to the vessel, when he paid us his state visit, in a sleigh drawn by two of his dwarfed subjects."

ON THE ESTHERVILLE, EMMET COUNTY, IOWA, METEORITE OF MAY 10, 1879.

By CHARLES UPHAM SHEPARD, Emeritus Professor of Natural History in Amherst College.

FOR the circumstances attending this third fall of aerolites in the State of Iowa since the year 1847, I am indebted to a notice published in the Chicago *Times* by Mr. S. E. Bemis, and to letters from Mr. Howard Graves and Mr. Henry Barber, of Estherville.

The fall occurred at 5 P. M. on the 10th of May, attended by a terrible explosion, resembling the discharge of a cannon, only louder. It seemed to proceed from a region high up in mid air; and was followed by a second report, more like a heavy blast. This again was succeeded by one or two more reports, that may have been echoes of the two first. Nearly a minute after, a rumbling sound was heard, apparently passing from the northeast to the southwest. The sky was clear at the time, or only a few fleecy clouds were visible. An observer, Mr. Charles Ega, looking in the direction of the report, could see nothing on account of the sun's rays; but following with his eye the direction of the roaring sound that succeeded, he saw dirt thrown high into the air at the edge of a ravine, one hundred rods northeast of where he was standing. At a like distance, still further away in the same direction, a similar disturbance of the ground was seen by Mr. Barber.

Another witness, Mr. S. W. Brown, living three-quarters of a mile distant, being in the edge of a wood, and having his eyes directed upward at the moment for the inspection of some oak trees, saw a red streak in the heavens; and while looking at it, the explosion took place. It appeared to him that the meteor was passing from west to east; and that when it burst, there was a cloud at the head of the red streak, which darted out of it like smoke from a cannon's mouth, and then expanded in every direction.

On examining the ravine where a body was seen to strike, a hole in the ground was discovered, twelve feet in diameter and six in depth. It was filled with water. Within this hole, at a depth of fourteen feet below the general surface of the ground, the large mass, weighing four hundred and thirty-one pounds, was found. It had penetrated a stratum of blue clay to the depth of six feet before its progress had been arrested. The mass measured twenty-seven inches in length, by twenty-two and three-quarters in breadth, and fifteen in thickness. Its surface is described as "fearfully rough," with ragged projections of metal. From one of these a portion was detached and shaped into a finger ring. After much searching, there have since been found, in the immediate vicinity of the hole, several smaller masses, varying in weight from one to eight ounces; also one mass of four pounds, and another of thirty-two.

At the distance of two miles from this spot, in a westerly direction, a mass of one hundred and fifty-one pounds was also discovered. It was embedded in a dry, gravelly soil, at the depth of four and a half feet. This specimen is in the possession of the University of Minnesota at Minneapolis.

DESCRIPTION OF THE METEORITE.

The specimens thus far received (for which I am indebted to Mr Graves), though numerous, are all small, the largest weighing only 147·7 grammes; nevertheless, accompanied as they are with a general description of the main mass, they afford the means of arriving at a tolerably clear conception of the general character of this very remarkable meteorite. It is marked by the unusual prevalence of chrysolite and meteoric iron, the former probably constituting two-thirds its bulk; also by the size and distinctness of the chrysolitic individuals, together with their pretty uniform, yellowish gray or greenish black color; and by the ramose or branching structure of the meteoric iron. Nearly one-half of the chrysolite, however, is more massive, approaching fine granular, or compact. Yet in this condition it is still highly crystalline, and difficultly frangible. This portion is of an ash gray, flecked with specks of a dull greenish yellow color. The luster is feebly shining. It is without any traces of decomposition; on the contrary, it is throughout a fresh, undecomposed crystalline aggregate. Especially is it observable, that the stony portions nowhere present traces of the oolitic, or semi-porphyritic structure, so common in meteoric stones.

The mean specific gravity of four examples of the stony portion was found to be 3·35. The crust upon this variety is of the usual thickness, black, without luster, and much wrinkled. One of the fragments shows a cavity of half an inch area, completely lined with a shining dark green glass, as if from the perfect fusion of chrysolite.

The meteoric iron, besides being in ramose branches, is also in enveloping coatings around the chrysolite, somewhat as in the Pallas and Atacama irons. The specific gravity of this aggregate, cleared of the stony part, was 5·97; that of the large specimen of 147·7 grammes was 4·54. The presence of schreibersite in the metal is apparent to the naked eye; also traces of the Widman figures which so constantly attend its presence, and to which they owe their production.

A very remarkable appearance is exhibited by the meteoric iron in some of the specimens. It is the bright silvery whiteness of the metal where it forms a portion of the exterior of the stone. It appears to have been fused and is surrounded on all sides by the black crust, coming from the stony material. It will be interesting to know whether this character prevails over the main mass from which these fragments were separated. If such should be the fact, it would give us a second case in which meteoric iron, seen to fall, reached the earth in the possession exteriorly of a high metallic luster. The other instance is that of the Dickson County meteorite, Tennessee, July 30, 1835.

The chrysolite, in large distinct concretions and highly crystalline individuals, deserves a particular notice. Some of these show imperfect crystalline facets, and nearly all the larger ones possess eminent cleavages. In a few instances they are nearly transparent and gemlike. Specific gravity (on 0·77 gramme) = 3·50.

The next most conspicuous species present is troilite. This also is in distinct individuals, sometimes as large as a pea. It is highly crystalline, rarely presenting splendent crystalline facets, whose color approaches silver white. The proportion in which it exists is apparently large, and may equal two per cent.

Next in importance comes the feldspathic mineral, presumably anorthite. It is highly crystalline, white, lustrous and nearly transparent, resembling in these particulars the similar mineral found among the ejecta of Vesuvius.

Among the specimens are two very distinct examples of an opal-like mineral of a yellowish brown color, which I take to be chassignite. Its luster is resinous, structure imperfectly slaty, to massive and conchoidal. A small granule of chromite occurs in one of the fragments of the massive chrysolite.

Such are the minerals thus far distinguished in the Estherville meteorite. As a whole, it differs widely from the normal meteoric stones. These differences consist, in the first place, in the unusual prevalence of a chrysolite similar to that found in the meteoric irons; secondly, in the large proportion of meteoric iron present, and in the manner in which it is involved with the chrysolite; thirdly, in the fresh and highly crystalline condition of all the constituents of the meteorite. Nothing like an aggregation of pulverulent, ash like grains, more or less rolled into oolitic shapes, so common in meteoric stones, is discernible. The stony portions much more resemble the olivinic rocks of extinct volcanoes, particularly those of the Eifel district.

Judging from the specimens in hand, it cannot properly be referred to any group of meteoric stones with which we are acquainted. It would rather appear to be a connecting link between the Litholites and the Lithosiderites, though it may possibly find a place in the Eucritic group of the former, in which case it would form an order by itself.—*American Journal of Science.*

A COMMUNICATION to the Anthropological Society of Paris contains some interesting results of a comparative examination by Dr. Bordier of the skulls of 35 murderers. They were all large like those of prehistoric man, and resembling the latter also in the excessive predominance of the parietal region over the small frontal development. The large capacities of the skulls were often associated with cerebral anomalies and defects, and in most cases the influence of heredity was clearly traceable.

BESSEMER'S GREAT REFLECTING TELESCOPE.

To most persons the word telescope conveys simply the idea of a small brass tube with a lens at each end, and having a portable mahogany tripod for its support; but the instruments used in our observatories are much larger and more substantially constructed, the object glasses attaining a diameter of 9 or 10 inches, the large equatorial at the Royal Observatory at Greenwich being 12½ in. diameter. The extreme difficulty of obtaining glass sufficiently pure and homogeneous for this purpose induced Sir Isaac Newton to try the principle of reflection instead of refraction, in which, after years of study and laborious experiment, he entirely succeeded. The Newtonian reflecting telescope has since taken a high position among philosophical instruments.

The large reflector constructed by Herschel, at Slough, has long since been dismantled, but the results obtained by it were so important as to induce the late Lord Rosse to expend some £12,000 on the construction of a very large reflecting telescope, which he erected at Parsonstown, in Ireland. This has been followed by the reflectors of Lassells and Nasmyth, and by larger instruments recently erected at Melbourne and Paris. The latter reflector is not made of an alloy of copper and tin, as in all the other cases, but is made of glass, the mass weighing in the rough 1,700 lb. On its surface is deposited, from a solution, a thin coating of pure silver, which gives a degree of brilliancy and absence of color which is truly admirable. The film of silver, which does not exceed the two hundred thousandth of an inch in thickness, is deposited on the front side and not on the back of the glass as in ordinary mirrors; hence the perfect homogeneity of the glass is no longer necessary. The silver on glass reflectors has the advantage of reflecting 90 per cent. of the incident light, while a speculum made of metal only reflects 63 per cent.; and as there are two reflections of the object in the Newtonian instrument, the silver on glass reflector sends to the eye of the observer as nearly as possible the same amount of light which a metal reflector of double the diameter is capable of transmitting. Most of the large reflecting telescopes are the work of gentlemen who, although of great ability as astronomers, would lay no claim to mechanical construction. They are certainly not conspicuous for their beauty of form, or for the mechanical appliances by which they are worked. Thus, Herschel's was a wooden structure, consisting chiefly of scaffold poles and ladders; while that of Lord Rosse has a wooden tube, and has only a limited movement between two parallel walls of masonry 45 ft. high, and is, therefore, incapable of surveying any desired part of the heavens at a particular time, the observer having to wait until the earth's motion brings the object opposite the end of the tube. These large instruments are all erected in the open air, requiring three or four assistants to work the pulleys and windlasses by which they are moved; and as the observer has to be placed at the upper end of the tube, which he must follow in all its varied positions, he has either to mount the scaffolding or walls, or to swing at the end of a crane some 30 ft. above the ground, a by no means pleasant position for an aged philosopher at one or two in the morning.

It is now nearly three years since the attention of Sir Henry Bessemer was directed to this very interesting subject. He had long previously amused himself with a 10 in. diameter reflecting telescope, and looked forward to the time when he might be able to devote his whole attention to this fascinating study; for to a mind like his the glory of the star-lit heavens must have offered irresistible attractions, and he is known to have frequently expressed his great desire to possess an instrument at least equal in power to anything hitherto constructed. It was with him, however, a desideratum that the instrument, notwithstanding its great magnitude, should be placed in a commodious and comfortable observatory, and not stand in the open air, exposed to all the vicissitudes of a climate like ours; and, further, that the instrument should be capable of being directed to any part of the heavens at will, without either waiting for the earth's motion or for the assistance of any one but himself, so that at any time of the night he could use it without climbing up long ladders, or lying on his back in an uncomfortable and constrained position. With this view he has designed an entirely novel self-acting telescope, at which the observer can sit or stand in an upright position at the center of the floor of the observatory, looking straight before him into the eye piece, which is placed 5 ft. 6 in. above the floor, and from which position he need not move one inch for the purpose of viewing an object visible at any part of the whole hemisphere above.

The degrees, minutes, and seconds in altitude and azimuth are recorded on a large dial, with two smaller ones inside it, to show minutes and seconds in a manner similar to the indication of time on a clock. These dials are situated immediately below the eye piece, all the dimensions being so large and easily seen as to dispense with the microscope used for seeing the fine lines of the ordinary divided circle. There are also two 7 in. achromatic refracting telescopes, attached to and moving with the large instrument, to serve as finders, and having their eye pieces in close proximity to the eye piece of the great telescope. The observatory in which this large instrument is to be erected is now approaching completion, and is admirably situated, commanding an uninterrupted view nearly down to the horizon on all sides. It consists of a massive dwarf tower of 80 ft. in diameter, with a stone balustrade and promenade around it.

In the center rises the observing room, which is also circular, the interior being 34 ft. in diameter and 23 ft. in height, lighted by eight large plate glass windows, thus forming an agreeable study or reading room for use in the daytime. In the lower part of the structure is placed a turbine, by means of which the observing room, with its floor, windows, and dome, revolve and keep pace automatically with any and every motion of the telescope, notwithstanding that the latter is wholly detached from the moving parts of the building, and stands firmly in the center on a massive masonry and concrete foundation, from which the upper end of the telescope reaches an altitude of 45 ft., where the tube is vertical.

Near the observatory there is a large workshop and laboratory, in which the reflector and some of the more delicate parts of the apparatus are now being made under Sir Henry's personal supervision; while the large axis and tube of the telescope, as well as several of the other massive parts, have been executed by the Messrs. Galloway, of Knot Mill Ironworks, Manchester.

The vertical axis of the telescope consists of a hollow ribbed cone of 3 ft. 6 in. diameter at its upper end, and carrying at its lower end a massive gun metal disk fitted spherically to the axis, and beneath which are three steel rollers resting on another gun metal surface, so that the massive structure may move round with great facility. The upper part of the axis is also supported laterally between adjustable anti-friction rollers. Passing these the axis is continued upward, in a horse-shoe form section, into the hollow open side of which the lower part of the telescope tube is allowed to enter so as to assume a perfectly vertical position when necessary. The telescope tube consists also of several open framed circular castings, very carefully and beautifully moulded, the end flanges of which are all accurately turned and fitted together. The center part of the tube is provided with hollow trunnions, on which it moves, and in one of which the eye piece of the telescope slides, so that in all possible positions of the instrument the eye piece remains in the same spot. The axes of the tube have fixed on them gun metal wheels of 4 ft. in diameter, resembling a locomotive driving wheel, but without a flange. Beneath these wheels are two similar ones of smaller diameter, supported on an adjustable bridge or lever, and passing between the wheels in a horizontal direction are two flat steel bars, terminating in piston rods and pistons, the latter working in large gun metal hydraulic cylinders. The motion endwise of these flat bars between the two wheels gives motion to the axis and alters the elevation of the instrument, thus acting like a rack and pinion, but without the unequal motion and lost time which the employment of teeth would give.

The necessity of applying motive power to effect all the motions of the instrument will be understood when we state that the moving parts of the telescope weigh between 11 and 12 tons, and by their solidity and motion give a degree of steadiness so generally absent, but so very necessary, in all large telescopes. The accurate fitting and general excellence of the workmanship of all the parts constructed by the Messrs. Galloway encourage the belief that this will be in many respects the finest reflecting telescope hitherto constructed. However desirable it may be to secure the comfort and convenience of the observer, it is of still greater importance that the optical parts of the instrument should be kept well in view, and it is to this point, we understand, that Sir Henry has devoted his most earnest attention. He first conceived the idea of constructing a special kind of lathe for the purpose of cutting with a diamond cutting tool the slight spherical concavity of the massive plate of glass which forms the reflector, and which is 50¼ in. in diameter. For this purpose he designed a lathe having beds 50 ft. in length, carrying a massive radius bar for describing the curved path of the diamond cutter, so as to give the precise focal length required.

There is also another important and novel machine designed by him for grinding and polishing the glass surface to an absolutely true spherical curve, after which it must be converted into a parabola of revolution, without which it would be absolutely useless. Some idea may be formed of the delicacy and difficulty of this operation when it is stated that the curved glass surface, which is 50¼ in. in diameter (3 in. in excess of the largest ever made), must have this surface reduced at the edges only one thirteen-thousandth of an inch, and gradually lessening by the law of the parabolic curve until the reduction in the center is *nil*. This operation of parabolizing the reflector is so extremely difficult that a true curve is rarely, if ever, attained, hence the price quoted by the trade for a glass parabolic reflector of 4 ft. diameter is no less than £2,000; this curve has hitherto been more or less perfectly attained by the dexterity acquired by long years of practice, and Newton himself, who made so many small reflectors, gave it as his opinion that no mechanical contrivance could possibly supersede this difficulty acquired art.

Scientific men are, therefore, the more anxious to see what will be the result of this part of Sir Henry's arrangements, for he proposes to give this parabolic form to the reflector by means of novel mechanism admitting of a degree of mathematical precision never yet attained in large reflectors. Should his plans be as successful in this as in the turning of the glass to shape with a diamond, a perfect glass reflector will not cost as many shillings as it at present costs pounds, and what is of still greater importance, his system of mounting comparatively thin plate glass on a marble backing holds out the prospect of our future telescopes being made at least four times as large as the one he is now making. In the interest of science, no less than for his own sake, we can but wish him the success which his enterprise deserves.—*Colliery Guardian.*

HANS & HERMARY'S ABSOLUTE BAROMETER.

AN ordinary barometer is sensitive to the influence of temperature, but one whose reservoir contains a certain amount of air (or of any gas whatever) is sensitive not only to this influence, but also to that of the pressure which the gas undergoes. By the simultaneous observation, then, of an ordinary and an air thermometer, we may ascertain variations of atmospheric pressure.

In order to put this principle in practice, while avoiding the use of calculation, the inventors of the "Absolute Barometer" have conceived the idea of determining the pressure by a very simple operation, and which is the exact translation of a geometrical theorem. Besides, by the adoption of certain new arrangements in the construction of the air thermometer, they have converted it into an instrument which is in no wise liable to get out of order, and which will last for an indefinite length of time. By these means they have surmounted difficulties in the presence of which all previous attempts had failed, and have constructed an apparatus which is at once accurate, convenient, and original.

The geometrical theorem may be stated in few words: When the temperature alone varies, the elongations of two thermometrical columns are in constant proportion to each other, and, consequently, if the tubes of the two thermometers are placed parallel to one another, the straight line which joins the ends of the columns will always pass through the same point, which we will designate as P. Now, if the pressure varies, the point, P, will change its position and pass through space in an exact straight line. Every position of the point, P, in the space corresponds with a determinate pressure, which may be indicated upon a scale; and the straight line which joins the extremities of the columns may be represented by a thread. It is possible, then, to construct a barometer, whose essential elements would be, an ordinary thermometer, an air thermometer, a graduated scale, and a thread; the tubes of the thermometers being placed parallel to each other, and the scale being suitably arranged with regard to them.

In practice, the instrument is rendered complete by the addition of certain accessories, and has been made to assume several forms, one of which is shown in Fig. 1, taken from *La Nature.* An explanation of this figure will be given further on.

The absolute barometric height, or, in other words, that which would be given by a good mercurial barometer at 0°, is read upon the arc of a circle which has been graduated with respect to the thread, which is so fixed as to pass through the center of the circle. The scale having been properly divided, it is evident that this amounts to the same thing as if the reading were done upon the geometrical space, P, of which we have spoken. It will be remarked that the divisions of this scale are about equidistant. A second graduation, borne on a movable sector, shows, for any given place, the height of the barometer reduced to the number of degrees at which it would stand at the level of the sea.

In the construction of the air thermometer, the first question that presented itself was that of the selection of a liquid to form the column to confine the gas whose variations of

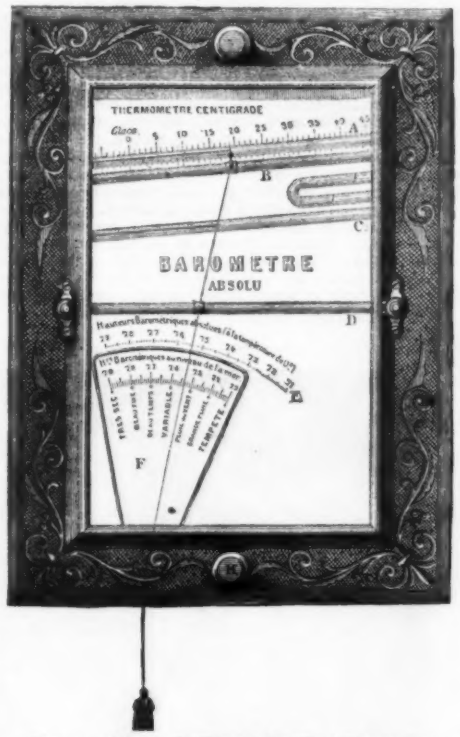


FIG. 1.—HANS & HERMARY'S ABSOLUTE BAROMETER.

volume were to be observed. The ranges of temperature that are exhibited by the climate of Europe made it necessary that this liquid should be of such a nature as to preserve a perfect fluidity, to emit no perceptible vapors, to exercise no action on the air of the reservoir, and, finally, to produce capillary effects that were perfectly constant. Sulphuric acid was chosen as filling all these conditions; but, as it absorbs moisture from the air, it became necessary to isolate it from the atmosphere by a second liquid column composed of a non-drying oil. Naturally, in order to avoid the chemical action of the acid upon the oil, these liquids had to be separated by a column of air. The sulphuric acid is colored with indigo. The two liquids are placed each in a U-shaped tube. This arrangement has several advantages, but is especially essential in that it allows of the use of a sling motion to drive out the air-bubbles which might form from separation in the liquid columns.

Fig. 2 represents an air thermometer, all the parts of which are shown in the same plane, in order to make the engraving more readily understood. The absolute barometer of Messrs. Hans & Hermary is a very convenient one for those persons who desire to make frequent observations for the purpose of following up meteorological variations. It might be thought that the manipulations necessary in consulting the instrument would prove a matter of inconvenience. But such is not the case; the operation is performed with the greatest facility, and, inasmuch as the indications of the last pressure observed are allowed to remain, it presents the additional advantage of furnishing a means of knowing every time the direction and value of the barometric variation.

This instrument, by very simple changes in the arrangement, may be made equally as available on shipboard as on land. From recent experiments it has been ascertained that the movements of the sea in no way affect the regularity of its indications.

The following is a description of Fig. 1: A, an ordinary thermometer. B, metallic rod carrying an index slide which is worked by means of a button placed at the top of the frame; the mechanism for transmitting the movement is hidden in the interior of the instrument. C, an air thermometer; D, metallic rod carrying a slide which is worked by a button at the bottom of the frame. The axis of this rod represents the place of the points, P. E, F, fixed and movable circular graduated scales. A thread attached to the upper slide passes through the lower one, thence through a fixed point at the base of the frame, where, hanging vertically, it is kept taut by means of a weight.

FIG. 2.—B, Reservoir. A, U-shaped tube containing sulphuric acid. C, U-shaped tube containing oil. D, open extremity.

To Consult the Instrument: The upper button is first worked so as to move the index slide up to the extremity of the column of the ordinary thermometer, then the lower button is worked so as to bring the thread even with the ex-

tremity of the column in the air thermometer; this done, the barometric pressure, or the signs of the weather, may be read on the scale beneath the thread.

MADAME BLANCHARD, THE AERONAUT.

FEMALE aeronauts have been far from rare, although their number falls far short of that of men who have pursued this calling; and so, too, the number who have met with fatal accidents is much less. We know of three only. One was Madame Blanchard. Another was Emma Verdier, a poor, ignorant young peasant girl, who had never seen a balloon, and whom a wretch, whose carelessness and imprudence made him almost an assassin, sent up in a Montgolfier, all alone, in order to increase the attraction of the spectacle! The scamp was tried at Mont-de-Marsan, the place of the as-

FIG. 1.—MADAME BLANCHARD.

cension; and this was the only time, we believe, that a man devoted to aerostatics has been tried in a criminal court. The third catastrophe, which happened on the 2d of April, 1875, ended an extraordinary voyage, and one that is scarcely known, although recent. This balloon trip was made by M. Galland and wife, from Rouen to Marseilles, and during the descent the husband was badly wounded, and the wife fatally, she dying eight days afterward. We know no further details in regard to the dramatic aerial trip, which was one of the longest that a balloon has ever accomplished.

Although Madame Blanchard was preceded by other women in the car of the balloon (Madame Thible was the first to ascend in a free balloon), she was the first one who made the aeronautic art her profession. For this reason, if for no other, she deserves to have her memory kept green. The circumstances surrounding her marriage were very singular, and redound to Blanchard's honor. At the beginning of 1778 this aeronaut, while passing through the village of Trois-Cantons, near Rochelle, observed a peasant woman who was working in the field, notwithstanding her advanced state of pregnancy. Touched by her poverty, and the courage that this fact denoted, the whimsical idea seized him to say to the woman that if her child should prove to be a girl, he would marry her as soon as she should reach the age of sixteen years. On the 25th of March of the same year young Marie Madeleine Sophie Armand was born in this Commune. Blanchard did not forget his adventurous promise, but, at the time fixed by him, kept his word.

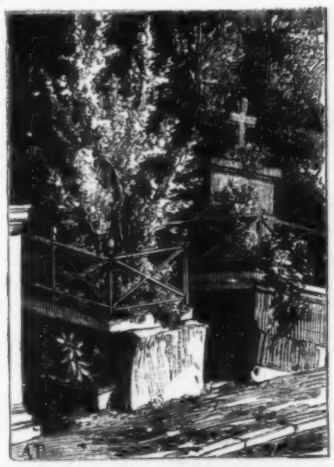


FIG. 2.—THE TOMB OF MADAME BLANCHARD, IN RUINS AT PERE LACHAISE, PARIS.

So long as her husband was full of life and health, Madame Blanchard made ascensions only for pleasure, but when he was struck by apoplexy (in the field of honor, it may be said), during an aerial voyage made in 1808 in the presence of King Louis at La Haye, she stood by him during the thirteen long months that he lay paralyzed and unable to help himself; and, after his death, she valiantly took up the career of him whom she had lost in order to obtain wherewith to live.

Madame Blanchard made throughout Europe—always alone—ascensions which at that time caused a great sensation, but the circumstances of which are now gradually being forgotten. Some of these, however, are still known: in 1805, at Toulouse; in 1810, in Paris, on the occasion of the marriage of Napoleon and Marie Louise; in 1811, at Rome and Naples; in 1812, at Turin, during an extreme cold which determined a hemorrhage; in 1817, at Naples, where she fell into a swamp; in 1818, when she descended upon a tree; and, at another time, she ascended so high that her face was covered with hoar frost; it is said that she slept on this occasion in her balloon and did not descend till morning.

Her last ascension only still remains fresh in the memory of those Parisians who saw the terrible spectacle; and an accurate account of it is religiously preserved in the writings of Dupuis Delcourt, a contemporary of the catastrophe.

It was on the evening of July 6, 1819—just sixty years ago. There was a great fête in the splendid Tivoli garden, whose secular shades are now replaced by market halls and the many railways terminating at the St. Lazare station. The crowd was large and brilliant, and it eagerly surrounded the lawn from whence Madame Blanchard was about to ascend. Still young, sprightly, and amiable, the fair aeronaut was beloved and respected by every one. She always did her best to please, and on the present occasion she had prepared a surprise for the admirers of her ability. In addition to the Bengal lights and golden rain which were suspended beneath her balloon, she carried in her car, along with a torch to light them, a second lot of fireworks attached to a parachute. There was a flourish of music, a blaze of fireworks, and Sophie Blanchard arose in a glory. The blue flames on the lawn were at first all that lighted up the voyager; then, as if by a secret sympathy, other azure flames burst forth beneath her car; and, finally, there was a simultaneous outburst of noises and brilliant fires both on the earth and in the heavens. Then a moment of calm succeeded. Every one was eagerly watching. . . . With one hand she seized her parachute, and with the other her lighted torch. . . . A dim light appeared in the car; the aeronaut threw down the torch and was seen to press the neck of the silken globe twice against her breast, when all at once a tuft of flame shot up from the top of the balloon.

FIG. 3.—DEATH OF MADAME BLANCHARD, JULY 6, 1819. (From an engraving of the period.)

"Beautiful! beautiful! vive Madame Blanchard!" exclaimed the crowd. While the immense throng was applauding, the balloon was seen descending, leaving behind it a luminous train. . . . It was on fire! it lighted up Paris like some immense moving beacon.

Sophie Blanchard no longer endeavored to extinguish the fire, but calmly made preparations for landing. The wind carried her over the vast gardens which at this time occupied the grounds back of the Rue de Provence. The gas took some time to burn; the balloon was not descending any too swiftly; and it seemed as if the fair aeronaut was going to be saved.

"Mine!" she exclaimed, and her little osier car touched the roof and slid along gently. As yet everything was safe—but suddenly a cramphook caught it and upset it, and Madame Blanchard was thrown into the street below. She was picked up dead. The tragic end of this woman, who, like the gladiator, had just died for their pleasure, made a profound impression on the Parisians. In a very short time a subscription was raised, large enough to purchase a perpetual concession at Père Lachaise, and a modest tomb was erected to her memory therein.

"We have just visited this humble mausoleum," says a writer in *La Nature*, "and its aspect inspired us with feelings of sincere melancholy. It is more than neglected; it is forgotten—unrecognizable; and without the help of a plan we would have been unable to find its location. Vegetation has overgrown it; roots have penetrated between the stones, forced them apart and overturned them; and rain and mosses have totally effaced the inscription. The tomb is mute. The contemporaries of the poor aerial heroine were desirous of giving her a perpetual proof of sympathy and regret. Posterity should not refuse to execute the trust. A very small sum, divided up between say twenty persons, would be sufficient to restore the little monument, with its inscription, . . . and thus preserve to our descendants the memory of poor unfortunate Marie Madeleine Sophie Blanchard."

[Continued from SUPPLEMENT, No. 194.]

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING OF 1879, AT SARATOGA SPRINGS, N. Y.

THE INTEROCEANIC CANAL PROBLEM.

By EDWARD P. LULL, A. M., Commander U. S. Navy.

Read before the American Association for the Advancement of Science, August 30, 1879.

IN the year 1870, the Government of the United States inaugurated a systematic series of explorations and surveys extending from Tehuantepec to the head waters of the Atrato river, for the purpose of locating, if possible, a ship canal route from the Atlantic to the Pacific, and the further object of making sure that the best or most feasible route had been selected. This last involved a vast amount of labor, which was simply that of elimination; in other words, the examination, far enough at least to prove its impracticability, of every locality where there was any promise or even possibility of finding a favorable line.

The limits of this paper will admit of but the briefest reference to the methods employed in the execution of the work; they will, however, be found fully described in the narrative portions of the published reports of the various expeditions. It will suffice to say that the methods employed depended much upon the character of the locality; much of the work was simply that of reconnoissance by the most rapid methods, in some cases were paced traverses with pocket compass and mountain barometer. I might here add that, owing to the very limited range caused by fluctuations of weather, barometric hypsometry is very much more trustworthy in tropical regions than in higher latitudes, particularly when, as was our practice, two barometers are used, one at a fixed station and the other carried over the line. If a line thus examined proved impracticable, it was abandoned as soon as the fact was established; but if it gave even moderate promise, the *gradienter* or the transit chain and spirit level were resorted to. In many instances the preliminary work even was done with these instruments. A few actual surveys had been made previously, and were entirely satisfactory. Singularly enough, notwithstanding the fact that this question has interested the world since the earliest discoveries of this continent, nearly all the successful examinations had been made by American engineers and army or navy officers.

With the few surveys just mentioned, some of which were again made, and those executed between 1870 and 1875 by order of the United States, I believe the information is sufficient to decide fully and definitely the question.

Several lines have been actually located, and computations, plans, and estimates made for the construction of canals upon them. These locations are accurate enough for comparison, and but little more is claimed for them. The time, means, and force available were entirely inadequate for an exhaustive final survey, such as should precede the actual work of construction, nor were any such surveys contemplated by the government. Some adverse criticism has been indulged in recently by persons clearly either entirely misinformed as to the methods actually employed, or else as to the object in view, but I am confident that any engineer who shall read the published reports will be satisfied fully that the object contemplated was entirely accomplished.

A commission appointed by the President, consisting of General A. A. Humphreys, Chief of Engineers, U. S. A.,

the Hon. C. P. Patterson, LL.D., Superintendent of the United States Coast and Geodetic Survey, and Rear-Admiral Daniel Ammen, Chief of the Bureau of Navigation, Navy Department, after a careful examination of the reports, plans etc., of the different surveys, decided that the route through the State of Nicaragua offered advantages, on the whole, decidedly greater than those of any other. A second route, viz. ,that by the Isthmus of Panama, was shown to be entirely practicable. These two are the only ones affording an open cut, *i. e.*, without tunnels, with a moderate amount of lockage. No practicable route for a canal at the sea level has been found, at all events none which is practicable in a commercial sense.

I shall attempt a brief description of the two lines above spoken of.

THE NICARAGUA LINE.

The line through Nicaragua includes, as one of its essential features, the lake of the same name. This body of water, with a superficial area of some twenty-seven hundred square miles, lies in the southwest portion of the republic. It is separated from the Pacific by a strip of land but ten miles wide at its narrowest point, viz., from Virgin Bay to San Juan del Sur. The surface of the lake at its highest stage, *i. e.*, about the end of the rainy season, is 107 feet above mean tide of either sea. The only outlet is the river San Juan, which flows from the southeast portion of the lake to the Caribbean Sea, a distance by the river of 119 miles. The lake drains an area, approximately, of 8,000 square miles; the average rise and fall of its surface level is six feet. The fluctuations of level are very gradual, the rise occupying the whole of the rainy season, and the fall the whole of the dry. There is deep water to within twelve hundred feet of the shore at the point where the proposed canal will enter the lake on the west side. On the east side a mud bank, with but 18 feet of water, extends seven miles from the outlet.

It is proposed to make the high water level of the lake the summit level of the canal. The lake will be connected with the Pacific by a canal of 16·3 miles length. The canal will leave the lake at the mouth of the Rio del Medio, nearly southwest and directly under the lea of the island of Ometepe. The first section, extending 7·58 miles, will be by far the most expensive portion of the work, requiring an average of 54 feet depth of excavation. From the end of this section to the sea the profile has been so adjusted that the excavation will be less than the prism of the canal, or in other words, the material excavated will be used to build up embankments on either side, and the water surface will be higher than the present surface of the ground. The line follows generally the valley of the small stream, the *Rio del Medio*, from the lake to the divide, and the valley of the *Rio Grande* thence to the sea, debouching at Brito, a point nine miles north of the port of San Juan del Sur. There will be required on this side ten locks, with a lift of a little over ten feet each, and one tide lock at Brito. The bed of the Rio Grande affords natural drainage for the canal, whose bed is everywhere, except in the tide water reach, above that of the river. An artificial harbor must be provided at Brito, and the conditions are very favorable for it. At present there is merely an angle in the coast line formed by the general trend of the shore on one side, and a bold rocky point which juts out into the sea on the other. Upon the very extremity of the point there is ample material for the necessary breakwater. The advantage of having to transport material so short a distance is very important.

DRAINAGE.

Every stream, dry water course, and valley, which might possibly bring water in times of heavy rains, has been provided for in the plans, either by ample culverts by changing its course, or in the case of some very small brooks by receiving the waters into the canal. An examination of the detailed estimates and plans will, I think, satisfy any engineer on these points.

EASTERN DIVISION.

It is proposed to connect the lake and the Caribbean Sea by means of slack water navigation and of canal, following the bed and the valley of the river San Juan—slack water navigation from the head to the confluence of the San Carlos, a distance of 63 miles, and independent canal from that point to the harbor of Greytown or San Juan del Norte. The navigation of that portion of the river which it is proposed to utilize is at present obstructed by rapids in four localities, viz.: the Toro rapids, 28 miles from the outlet; the Castillo, 37 miles distant; the Mico and Balas rapids, 7 miles further; and finally, the Machuca rapids, 48 miles from the head. Between the Machuca rapids and the mouth of the San Carlos the San Juan is deep and sluggish, and bears the name of *Agua Muerta*, or Dead Water. The San Carlos is the first considerable tributary of the San Juan ; it takes its rise in the volcanic regions of Costa Rica, and brings down enormous quantities of silt, mainly a volcanic sand, so light as to be held in almost complete suspension by rapidly flowing water. It is this material principally which forms the delta of the San Juan, and by which the once magnificent harbor of Greytown has been so nearly destroyed. The San Juan itself, below the mouth of the San Carlos, is filled with bars and shoals from the same source. Above the San Carlos the main river is very free from silt. The bank, already mentioned, at the foot of the lake, is composed of a stiff mud, the accumulated deposit of ages.

The lake, with the gradual rise and fall of its surface level, acts as a great equalizer, and renders the character of the upper part of the San Juan very different from that of most tropical streams whose freshets are violent and sudden. From the Castillo rapids down the river is, to be sure, subject at times to considerable floods, but these are produced mainly by back water from the San Carlos and lower tributaries, as is proved by the very considerable deviation of the river current at such times. It is proposed to cut off this back water, as will be shown further on.

It is proposed to produce slack water navigation by the erection of four dams—one at Castillo, one at Balas, one at Machuca, and one just below the present mouth of the San Carlos. The proposed sites for the dams are magnificent. Each is located in a wide part of the river, abuts upon a hill on either bank, and all, save that at San Carlos, have rock foundations. At the last named point there is a solid bed of gravel which doubtless overlies rock, though in the estimates a pile foundation has been provided for. The dam at Castillo will raise the water behind it to the level of "high lake." Each of the other three will raise its waters to within 10·28 feet of those next above. There will have to be removed some rock in the channel over the *Toro rapids*, which should, of course, be done before the dam is built. There will also have to be some improvement by dredging between that point and the head of the river, and a channel dredged for the seven miles already spoken of from the outlet of the lake to the 25 foot curve. A short reach of canal with one left lock will be required to pass each of the upper three dams. As I have said, it is proposed to build dam No. 4 just below the present mouth of the San Carlos. It is then proposed to turn the San Carlos, giving it a new mouth below the dam, which will thus cut off the floods from the upper river. On account of these floods and of the shoals and sandbars, the river cannot readily be utilized below this point. A canal is therefore proposed, leaving the left bank of the river just above the dam and leading by the shortest practicable traverse to the harbor of Greytown, depending on the profile, that is, following the lowest levels, where it could be done without adding unduly to the distance. The sections, like those in the Pacific division, are composed of straight reaches, and of arcs of circles, the least radius in the latter being 2,200 feet, which gives a middle ordinate for 400 feet of but 9 feet; in other words, the middle point of the keel of a ship 400 feet long would be but 9 feet out of the axis of the canal when her bow and stern were exactly in the axis.

Seven locks will be required in this portion of the canal, making, with the three already spoken of, ten in all, of a little over ten feet lift each.

DRAINAGE.

As in the case of the Western division, the drainage is provided for by the arrangement of the profile with reference to that of the natural surface, and every stream and valley has its culverts or cess-pools, as the case demands, as will be seen by reference to the plans in the published report.

THE HARBOR AT GREYTOWN.

The river San Juan discharges its waters through two mouths, the Colorado and the lower San Juan. The Colorado discharges at the low stage 99 per cent. of the river flow. Its current is opposed directly to the sea, produced by the prevailing trade-winds, forming an ugly bar off its mouth. The lower San Juan empties into the Bay of Greytown, once a magnificent harbor, but now a mere shallow lagoon. Twenty years ago I saw ships of war anchored where now there is scarcely water for a canal. The material with which it has been so nearly filled up is the silt already spoken of as coming from the San Carlos river, and which is brought down in enormous quantities during the rainy season. A cordon of sand now closes up the entrance of the harbor almost entirely for the greater part of the year, though during freshets it is broken through, sometimes in one place, sometimes at another. The cordon extends from the main shore just north of Greytown, in a direction about E. by N. Twenty years ago the out portion of it only existed in the form of a hook, which was known as *Punta Arenas*, and between the point and the mainland there was a deep channel. This was entirely closed up, a year later, by the waste material from a break farther out during a freshet. The sea caused by the trade wind comes from a little to the northward of the travel of the outer beach. The river enters the harbor by two mouths, the principal of which empties into that part of the bay known as Harbor Head, very near the inclosing sand strip. A small opening near this point is always maintained, though constantly shifting its position. During the rainy season, the river current being very strong, and the sea outside comparatively still, owing to the interruption of the trade winds, large quantities of silt are carried outside the cordon, the opening in which becomes wide and comparatively deep. As the rains begin to slacken, and the trade wind to increase at the change of season, the sea transports the silt to leeward, and generally closes up any opening that may have been made near the old entrance, just as it did on the first occasion above referred to. The filling up of the harbor basin has been largely assisted by the luxuriant vegetable growth, more especially of aquatic species. The cordon, owing to its shifting character, is mainly lost, and no effort whatever is made by the authorities or inhabitants to assist nature in placing her ligatures upon its unstable sands, and thus giving it some degree of permanency.

THE RESTORATION OF THE HARBOR.

The plan which I propose for the restoration of the harbor of Greytown is as follows:

First, to throw a dike across the head of the lower San Juan, just below the forks, and thus turn all the silt-bearing waters through the Colorado, whose mouth is 18 miles south of Greytown. This, by cutting off the supply of silt, and what is of greater immediate importance, by cutting off the freshets, and thus preventing the breaking through and waste of the cordon, will make possible the next step, *i. e.*, that of binding together the material of the cordon, as above suggested, by planting *mangrove* all over its surface, and by adopting the usual methods for protecting the outer face, viz., piling, mattresses, etc., as far as found necessary, the supply of material which could be moved by the sea would soon be exhausted. An entrance must then be opened, near its old place, and protected by a breakwater extending some three thousand feet in a northwest by north direction, or out to the 35 foot curve. Portions of the basin of the harbor would have to be deepened by dredging. The waters of the canal, being free from silt, would be admitted to the harbor, which would also receive the drainage of the San Juanillo, a small stream whose waters are also clear. I believe that the plan, here given in its merest outline, will be effectual in restoring the harbor and making it adequate for the purposes needed, that is, a protected entrance for the canal.

DIMENSIONS, ETC.

The total distance from sea to sea, by the route as we have laid it down, is 180·7 miles. Of this there will be 56 miles of lake, 63 of slack water navigation, and 61·7 miles of canal. In constructing the canal proper there will be required an average depth of excavation of but nine (9) feet in addition to the prism of the canal; 47·4 miles will be in excavation and embankment. Of the remaining 14·3 miles there will be one section of deep cutting of nearly 7 miles. The rest is composed of short cuts through hills and around the dams.

I need hardly suggest to this body that the very general custom of comparing lines by their length only gives but a very unfair idea of their relative merits, since the banks, to be self-sustaining, must have a certain amount of outward slope. The depth of excavation is a much more important factor than the length.

It is proposed to give the following dimensions to the canal, viz.:

	Wide Prism. In rock.	Prism. In earth.	Reduced Prism. In rock.
Width at bottom	72 feet.	72 feet.	60 feet.
Width 10 feet from bottom	..	..	90 "
Width at water surface	126 "	150 "	106 "
Depth	26 "	26 "	26 "

The reduced prism is proposed for the deep cut through the summit on the Pacific side.

LOCKS.

It is proposed to give the locks a length of 400 feet between miter-sills, and 72 feet width of chamber. The design for the locks, by Mr. A. G. Menocal, Civil Engineer, U. S. A., will be found described in the published report.

With the exception of the first section of the Western division, there is abundant room for the deposit of material near at hand.

It is proposed to give the banks a slope of 1½ horizontal to 1 vertical in earth (33°), and ¼′ horizontal to 1′ vertical in rock.

WATER SUPPLY.

The gauge of the river San Juan at the lowest stage showed a discharge of twenty times the greatest possible demand for operating the canal.

ESTIMATES.

The estimates of cost of constructing a canal by this route will be found in detail in the published report of the survey. They amount in the aggregate to $66,000,000.

THE PANAMA ROUTE.

The route for a canal across the Isthmus of Panama, as laid down by the surveying expedition of 1875, extends from the Bay of Aspinwall on the Caribbean, to that of Panama on the Pacific side. It follows in general the valley of the river Chagres from Aspinwall to the great bend of that stream at Matachin. At Matachin it is proposed to cross the Chagres by means of a viaduct. The line then follows the valley of the Rio Obispo, a small tributary of the Chagres, to the divide, crossing which it follows the valley of the Rio Grande to the Bay of Panama.

It is proposed to supply water for the canal by means of a feeder tapping the Chagres some ten miles above the point of crossing, raising the river surface to a sufficient height by means of a dam to be constructed for the purpose.

The location chosen for the viaduct to cross the Chagres is admirably adapted for the purpose. It is at a point where the near approach of the two ranges of hills inclosing the valley of the river afford excellent abutments for the viaduct, at the same time giving ample room for a sufficient number of culverts to discharge the waters of the river in time of floods. From the southern end of the viaduct the line continued strikes directly into the valley of the Obispo River, and, after passing the divide, into that of the Rio Grande, these two valleys leading by the shortest distance and best profile to the Bay of Panama.

The highest water-marks, *i. e.*, the surface level of the water in extreme floods, was found to be 78 feet above mean tide of either sea, a difference of 35 feet from the ordinary low water level at the same point. Adding to this the rise of arch of the culverts, the necessary thickness of wall over the crown of the arches, and the depth of water gave 124 feet as the necessary surface level of the water in the viaduct. To descend from this level to the sea requires twelve locks of a side, or two more than are needed in the Nicaragua line. A lower level would necessitate going further down the river for a crossing, and would necessarily increase the depth of excavation in the cut through the divide.

The proposed viaduct, which is described in detail in the published report, will be 1,900 feet in extreme length, will rest upon piers 90 feet apart, forming twelve culverts, varying in length from 40 feet to 12 feet according to location. The water way will be 65 feet wide and 26 feet deep. The thickness of the walls and the cross-section of the piers are proportioned for the burdens they are expected to carry.

The surface level of the water in the viaduct is proposed as the summit level of the canal. From the southern end of the viaduct the line extends by straight reaches and curves, which are arcs of circles, following the routes already indicated to Panama. The first 4·8 miles carries the line through the summit. The deepest cut will be 170 feet, while the average depth will be 76 feet, in addition to the prism of the canal. From the end of the summit cut to the terminus the average depth of excavation will be but a little more than the prism of the canal. The total distance from the viaduct to the Bay of Panama by the traverse is 15 8 miles.

From the northern or Atlantic end of the viaduct the line extends for 7·6 miles through very broken country along the right bank of the Chagres, then for 3·7 miles through low and occasionally swampy land; hilly country is next met for about the same distance, after which it is low and swampy to the end of the line. Except in the ten miles of broken country and in the tide water reaches, the excavation will be on the average less than the prism of the canal. The total distance from viaduct to Aspinwall is 25 9 miles, making the distance from sea to sea 41·7 statute miles.

Twelve locks and one tide lock, with a lift of a little over 10 feet each, will be required on the Pacific side, and twelve lift locks on the Atlantic side.

DRAINAGE.

Every stream and watercourse met with has been provided for by culverts, by a new channel, or in the case of a few small rivulets by receiving the waters into the canal.

WATER SUPPLY.

The water supply from the Chagres is ample, though at the very low slope there would not be much from that source to spare. The enormous amount of spring water would, however, largely supplement it, so that there would never be any difficulty on that score. The superabundant waters at the higher stages have ample room for escape under the canal through the culverts already spoken of.

THE FEEDER.

The location of the feeder was very difficult, and involves tunneling for a total distance of 13,700 feet in sections varying from 300 feet to 5,600 feet in length. There will also be needed two sections of aqueducts, or possibly inverted siphons, of 4,580 feet and 12,000 feet lengths respectively.

HARBORS.

A channel will have to be deepened in Panama Bay for a distance of 9,200 feet to the 18 foot curve. This will give an 18 foot channel at dead low water, and at and above mean tide of 25 feet and over.

At Aspinwall, where there is no help from the tide, the channel must be improved out to the 26 foot curve, a distance of 1,800 feet. A breakwater will also be required to make this harbor entirely safe from *northers*, though it is sufficiently well protected from the sea, produced by the prevailing trade winds, and gales are fortunately of rare occurrence.

The line of the canal laid down is nowhere more than one mile from the track of the Panama railroad.

The total estimated cost of building a canal of the same dimensions as proposed for that in Nicaragua is $94,000,000, against $66,000,000 for the latter, the difference being the increased amount of excavation, owing to a less favorable profile, the cost of the viaduct of the feeder, and of the four additional locks required.

Materials for construction are much more abundant and accessible in Nicaragua than in Panama, the climate is more salubrious, and the Pacific terminus of the Nicaragua line is 600 miles nearer to San Francisco than Panama. The difference of distance between the Atlantic two termini and the eastern ports of the United States is inappreciable.

Owing to the enormous rainfall which annually visits the isthmian region, a canal without locks, or in other words one at the sea level, must act as the ultimate drain of a greater or less area; and since to reduce the excavation it must follow the valleys, the extent of those valleys and of others leading into them will determine the extent of the watershed. The surface water from these valleys and from the streams now existing can of course be kept from flowing into the canal by providing side drains of sufficient cross section to discharge them, which would be an enormous additional expense. There is another element, however, which cannot be avoided and whose amount can only be conjectured: that is the spring water. In the two lines I have attempted to describe the profiles are so laid down that except on the tide water reaches, where it is expected the work will be done by the dredge, natural drainage is provided; but in case the excavation is carried so low that there is no chance for the water to flow off, say for a canal at the sea level, there must be either drainage by pumping or the excavations must be executed under water. The former, I believe, would be impossible; the latter so expensive that it is commercially out of the question.

Among the schemes proposed at the recent congress in Paris was that of receiving the waters of the Chagres into the proposed canal *à niveau*. At the lowest stage of the water this might be done, *if there was no other supply of fresh water*, without producing any great trouble; but in times of high water it would give a current which would not only render it impassable for ships, but would move the banks in all portions not in rock or not protected by masonry; would produce sand banks and shoals, particularly with the silt and drift brought down by the river, and would naturally, at the two entrances, form bars like those at river mouths.

No attempt, as far as I am aware, has been made to compute the probable cost of a canal at the sea level, such as is proposed by M. Lesseps and his associates. I will, as an illustration of the additional cost over that in the scheme proposed by us, make a comparison of what *we know* as the summit cut in the proposed Panama line with the same carried down to the sea level. The distance is 8,448 yards. The average depth for a canal with locks is 75 feet; in the canal at sea level the average would be 181 feet. Assuming the cross section proposed for the narrow portions, viz.: 106 feet width at the water surface, allowing a slope of ¼ foot horizontal to 1 foot vertical in rock, and 1½ foot horizontal to 1 foot vertical in earth, and supposing the earth to overlie the rock for an average depth of 20 feet, we should have, allowing $1.40 per cubic yard for excavation in rock and 40 cents per cubic yard in earth:

	Canal with locks.	Canal at the sea level.
Excavation in rock.	6,082,560 cu. yds.	25,344,000 cu. yds.
" earth	3,227,336 "	4,452,940 "
Total cost of sect'n,	$10,444,774	$39,497,176

In this comparison the same cost per cubic yard is estimated for in both cases, which is manifestly unfair to the section having the least depth of excavation, since the deeper the cut the greater distance it will be necessary to transport material, to say nothing of other disadvantages.

The Panama route certainly offers, of all that have been examined, the least unfavorable conditions for a canal at the sea level, but even there the number of streams which are intersected by the line, *i. e.*, the Chagres and its tributaries, could only be diverted at enormous cost for new channels.

The expense of passing locks and the consequent delay to ships in transit, and the cost of keeping locks in repair, are disadvantageous, which it would be well to avoid if possible; but on the other hand, the freedom from currents and from obstructions; the fact that when repairs may be needed, any reach, save those at tide water level, may be drained by simply drawing off the water; and above all, the enormous difference of original cost, make it an easy matter to decide in favor of a canal with locks; and indeed, the question, practically, is reduced to a choice between a canal with locks or none at all.

It would be difficult to say what may be the limits of possibility to engineering skill; but, in my belief, a canal without locks is, to say the least, a much nearer approach to it than this generation is likely to undertake to accomplish.

ON THE FERTILIZATION OF YUCCA.

By THOMAS MEEHAN, Prof. of Botany to the Pennsylvania Board of Agriculture.

Read before the American Association, Saratoga Springs, 1879.

IN the transactions of the Academy of Science of St. Louis, of April 15, 1873, our distinguished associate, Dr. Geo. Engelmann, has some notes on the genus Yucca, in which occurs the following passage: "The conspicuously papillose termination of the pistil had always been considered the stigma, but closer examination showed its papillæ to be epidermal appendages, corresponding to similar ones on the filaments, and entirely destitute of stigmatic function; never did they contribute to the development of a pollen grain occasionally adhering to them. Dr. Mellichamp's notice of a glutinous liquid in the tube, formed by the coalescence of the so-called stigmas, led me to further experiments. That tube proved to be the real stigma, exuding stigmatic liquor, and insects must be the agents which introduce the pollen into the tube."

Subsequent investigations by our esteemed associate, Prof. Riley, led to the discovery of a new genus of Lepidoptera—*Pronuba yuccasella*—and which has proved to be the insect-agent which fertilizes the flower. In the same number of the proceedings, Prof. Riley describes this insect, and says: "With her maxillary tentacle, so wonderfully modified for the purpose, she collects the pollen in large pellets, and holds it under the neck and against the front trochanters. In this manner she sometimes carries a mass thrice the size of her head. Thus laden, she clings to the top of the pistil, bends her head, thrusts her tongue into the stigmatic nectary, and brings the pollen masses right over its mouth. In this position she works with a vigor that would indicate combined pleasure and purpose, moving her head and body from side to side, and apparently making every effort to force the pollen into the tube. Such is the method by which our yuccas are fertilized."

It may be remembered that at our meeting at Buffalo I produced three capsules that had not been produced by this elaborate process, but simply by my mere touching of the papillose apex with one of the flower's own polleniferous anthers. Professor Riley was so sure that the seed-vessel could not have been produced in that way—that there must have been some insect-agency unknown to me in addition to my work—that at the conclusion of my paper he asked permission to cut open the capsules, sure of being able to show the larvæ in the fruit, but he found them not. I recall these matters to show that I have not misapprehended the position our friends take on this question.

I now exhibit numerous seed-vessels from this plant of *Yucca angustifolia*, in which no trace of larvæ can be found; and seed-vessels of *Yucca filamentosa* growing but a few yards from the other, which are infested by the *Pronuba yuccasella*, as this species always is when it seeds at all.

The history of the fruiting of this yucca is as follows: It flowered in 1875, but produced no fruit. In 1876, the early flowers proving infertile, I applied the flower's own pollen to the apex of the pistil of the four last flowers that opened; these produced the four capsules examined by Prof. Riley, as already noted. In 1877, noticing that the pronuba abounded in the flowers, no hand application was made, and there was no fruit. In 1878 the flowers were again left to the insects, with no fruitful results. The past season, pollenization by hand was resorted to, and the same seed-vessels I exhibit are the result. As the pollen was merely applied to the apex of the pistil, it shows that in this species the elaborate and wonderful ingenuity of the insect in applying pollen, as described by our friends, is wholly unnecessary.

We now come to some extremely interesting considerations growing out of these facts:

Pronuba yuccasella, the yucca moth, has for years abounded on my flowers of *Yucca filamentosa*. It has not been known to visit any other plants than yucca. *Yucca angustifolia* begins to flower from three to two weeks, and its blossoming is all over before *Yucca filamentosa* begins to open. The facts now adduced show that the moths exist weeks before the flowers bloom with which they have so intimately connected, feeding, of course, on other flowers, and would perhaps make use of other fruits as depositories for their eggs, if yucca should not exist. At any rate, the facts weaken any belief we may have that the yucca and yucca moth, through the long ages, have become mutually adapted to each other through a fancied mutual benefit.

But the fact remains, that the yucca is so arranged that it must have external aid before it can use pollen, and it is believed that this arrangement is for the express purpose of facilitating the introduction of strange pollen; and, further, that this arrangement must be useful or it would not exist. And then it is assumed that this useful purpose can only be understood by believing that cross-fertilized seed is of the most benefit to the race. Let us examine this reasoning in the light of facts.

In 1871 I found *Yucca angustifolia* seeding abundantly, but when the interesting matters in its history were brought out by Prof. Riley, I could not remember whether the seed-vessels were infested by the larvæ of the yucca moth, and was glad to revisit Colorado in 1873 to examine the plants; but I did not find one seed-vessel in several weeks' search for them. I have since engaged friends to get me some, but none have found them. In order to test the matter thoroughly, I engaged a professional seed-collector in Southern Utah to buy of him a pound of seed, each of the several species; and recently I have heard from him, the third successive year, that no plant within his observation had produced a single seed. How can we believe that this elaborate arrangement for producing seeds by cross-fertilization through insect agency is for the purpose of producing a better class of seeds, when we see in many cases plants utterly fail, even for successive years, to seed at all?

We know that it is not to the interest of the individual to produce any seed. Seed is a provision of nature looking to the good of the future, and to which the present good of the individual is often sacrificed. The mignonnette, the petunia, and many other plants under garden culture, live for years when prevented from perfecting seed. We may fairly believe that a plant which acquires the power of a more individual increase and persistence, would show less disposition to sacrifice itself on seed; and this we do find in nature, that it is among that class which has the most of this individual persistence, that the indifference to perfecting seeds, popularly known as "arrangements for cross-fertilization," is found, and, moreover, that the most difficulty in germinating is met with even when the seed is freely formed.

The yucca, by its large fleshy root-stocks and ability to withstand extremes of drouth and heat and cold, is able to maintain an existence indefinitely without producing any seed. For the sake of inducing variation, which is best accomplished through seeds, it may be compelled by inexorable law once in a while to produce them, but the law which is to result in the evolution of new forms will hardly be adduced in favor of any theory which has for its foundation the idea of benefit to an existing race.

INFLUENCE OF PRESSURE ON SPECTRA.

HERR CIAMICIAN has contributed experiments on this subject to the Vienna Academy. The spectra of chlorine, bromine, and iodine show the same peculiarities under increased pressure; the bright lines becoming broader, but not spreading into bands, a continuous illuminated background appears which often overpowers the lines. The spectrum of sulphur does not change at all, neither does that of phosphorus and arsenic.

Metals behave very differently. Here a real band-like extension of the spectral lines takes place, while the continuous light remains subdued. In the mercury spectrum the enlargement of the green and violet lines is specially noteworthy. In the sodium spectrum the enlargement is very considerable, but can only be observed with the reversed or dark D line. Under high pressure sodium gives a continuous background in the immediate neighborhood of the D line upon which the reversed line appears. The double line gradually merges into one, becoming wider until it finally covers the whole background.

BRITISH ASSOCIATION—THE PRESIDENT'S ADDRESS.

AT the forty-ninth meeting of the British Association for the Advancement of Science, commenced at Sheffield on the 20th August, Prof. G. J. Allman, M.D., F.R.S., President, delivered the following address:

I propose to give you in as untechnical a form as possible some account of the most generalized expression of living matter, and of the results of the more recent researches into its nature and phenomena.

PROTOPLASM.

More than forty years have now passed away since the French naturalist Dujardin drew attention to the fact that the bodies of some of the lowest members of the animal kingdom consist of a structureless, semi-fluid, contractile substance, to which he gave the name of sarcode. A similar substance occurring in the cells of plants was afterward studied by Hugo von Mohl, and named by him protoplasm. It remained for Max Schultze to demonstrate that the sarcode of animals and the protoplasm of plants were identical. The conclusions of Max Schultze have been in all respects confirmed by subsequent research, and it has further been rendered certain that this same protoplasm lies at the base of all the phenomena of life, whether in the animal or vegetable kingdom. Thus has arisen the most important and significant generalization in the whole domain of biological science. Within the last few years protoplasm has again been made a subject of special study, unexpected and often startling facts have been brought to light, and a voluminous literature has gathered round this new center of research. I believe, therefore, that I cannot do better than to call your attention to some of the more important results of these inquiries, and endeavor to give you some knowledge of the properties of protoplasm, and of the part it plays in the two great kingdoms of organic nature.

As has just been said, protoplasm lies at the base of every vital phenomenon. It is, as Huxley has well expressed it, "the physical basis of life." Wherever there is life, from its lowest to its highest manifestations, there is protoplasm; wherever there is protoplasm, there, too, is life. Thus coextensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what the ether is to the physicist; only that instead of being a hypothetical conception, accepted as a reality from its adequacy in the explanation of phenomena, it is a tangible and visible reality, which the chemist may analyze in his own laboratory, the biologist scrutinize beneath his microscope and his dissecting needle. The chemical composition of protoplasm is very complex, and has not been exactly determined. It may, however, be stated that protoplasm is essentially a combination of albuminoid bodies, and that its principal elements are, therefore, oxygen, carbon, hydrogen, and nitrogen. In its typical state it presents the condition of a semi-fluid substance—a tenacious, glairy liquid, with a consistence somewhat like that of the white of an unboiled egg. While we watch it beneath the microscope movements are set up in it; waves traverse its surface, or it may be seen to flow away in streams, either broad and attaining but a slight distance from the main mass, or else stretching away far from their source, as narrow liquid threads, which may continue simple, or may divide into branches, each following its own independent course; or the streams may flow one into the other, as streamlets would flow into rivulets and rivulets into rivers, and this not only where gravity would carry them, but in a direction diametrically opposed to gravitation. Now we see it spreading itself out on all sides into a thin liquid stratum, and again drawing itself together within the narrow limits which had at first confined it, and all this without any obvious impulse from without which would send the ripples over its surface or set the streams flowing from its margin. Though it is certain that all these phenomena are in response to some stimulus exerted on it by the outer world, they are such as we never meet with in a simply physical fluid—they are spontaneous movements resulting from its proper irritability, from its essential constitution as living matter. Examine it closer, bring to bear on it the highest powers of your microscope—you will probably find disseminated through it countless multitudes of exceedingly minute granules; but you may also find it absolutely homogeneous, and, whether containing granules or not, it is certain that you will find nothing to which the term *organization* can be applied. You have before you a glairy, tenacious fluid, which, if not absolutely homogeneous, is yet totally destitute of structure. And yet no one who contemplates this spontaneously moving matter can deny that it is alive. Liquid as it is, it is a living liquid; organless and structureless as it is, it manifests the essential phenomena of life. The picture which I have thus endeavored to trace for you in a few leading outlines is that of protoplasm in its most generalized aspect. Such generalizations, however, are in themselves unable to satisfy the conditions demanded by an exact scientific inquiry, and I propose now, before passing to the further consideration of the place and purport of protoplasm, to consider such as are actually met with in the organic world.

REALITY OF THE "BATHYBIUS."

A quantity of peculiar slimy matter was dredged in the North Atlantic by the naturalists of the exploring ship Porcupine from a depth of from 5,000 to 25,000 feet. It is described as exhibiting, when examined on the spot, spontaneous movements, and as being obviously endowed with life. Specimens of this, preserved in spirits, were examined by Prof. Huxley, and declared by him to consist of protoplasm, vast masses of which must thus in a living state extend over wide areas of sea bottom. To this wonderful slime Huxley gave the name of *Bathybius Haeckelii*. Bathybius has since been subjected to an exhaustive examination by Professor Haeckel, who believes that he is able to confirm in all points the conclusions of Huxley, and arrives at the conviction that the bottom of the open ocean, at depths below 5,000 feet, is covered with an enormous mass of living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. He suggests that it may have originated by spontaneous generation, but leaves this question for future investigators to decide. The

reality of Bathybius, however, has not been universally accepted. In the more recent investigations of the Challenger the explorers have failed in their attempts to bring further evidence of the existence of masses of amorphous protoplasm spreading over the bed of the ocean. They have met with no trace of Bathybius in any of the regions explored by them, and they believe that they are justified in the conclusion that the matter found in the dredgings of the Porcupine and preserved in spirits for further examination was only an inorganic precipitate due to the action of the alcohol. It is not easy to believe, however, that the very elaborate investigations of Huxley and Haeckel can be thus disposed of. These, moreover, have received strong confirmation from the still more recent observations of the Arctic voyager, Bessels, who was one of the explorers of the ill-fated Polaris, and who states that he dredged from the Greenland seas masses of living undifferentiated protoplasm. Bessels assigns to these the name of Protobathybius, but they are apparently indistinguishable from the Bathybius of the Porcupine. Further arguments against the reality of Bathybius will therefore be needed before a doctrine founded on observations so carefully conducted shall be relegated to the region of confuted hypotheses. Assuming, then, that Bathybius, however much its supposed wide distribution may have been limited by more recent researches, has a real existence, it presents us with a condition of living matter the most rudimental it is possible to conceive. No law of morphology has as yet exerted itself in this formless slime. Even the simplest individualization is absent. We have a living mass, but we know not where to draw its boundary lines; it is living matter, but we can scarcely call it a living being. We are not, however, confined to Bathybius for examples of protoplasm in a condition of extreme simplicity. Haeckel has found, inhabiting the fresh waters in the neighborhood of Jena, minute lumps of protoplasm, which, when placed under the microscope, were seen to have no constant shape, their outline being in a state of perpetual change, caused by the protrusion from various parts of their surface of broad lobes and thick finger-like projections, which, after remaining visible for a time, would be withdrawn, to make their appearance again on some other part of the surface. These changeable protrusions of its substance, without fixed position or definite form, are eminently characteristic of protoplasm in some of its simplest conditions. They have been termed "Pseudopodia," and will frequently come before you in what I have yet to say. To the little protoplasmic lumps thus constituted, Haeckel has given the name of *Protamœba primitiva*. They may be compared to minute detached pieces of Bathybius. He has seen them multiplying themselves by spontaneous division into two pieces, which, on becoming independent, increase in size and acquire all the characters of the parent. Several other beings as simple as *Protamœba* have been described by various observers, and especially by Haeckel, who brings the whole together into a group, to which he gives the name of Monera, suggested by the extreme simplicity of the beings included in it.

THE FAMOUS AMŒBA.

But we must now pass to a stage a little higher in the development of protoplasmic beings. Widely distributed in the fresh and salt waters of Britain, and probably of almost all parts of the world, are small particles of protoplasm closely resembling the *Protamœba* just described. Like it, they have no definite shape, and are perpetually changing their form, throwing out and drawing in thick lobes and finger-like pseudopodia, in which their body seems to flow away over the field of the microscope. They are no longer, however, the homogeneous particle of protoplasm which forms the body of *Protamœba*. Toward the center a small globular mass of firmer protoplasm has become differentiated off from the remainder, and forms what is known as a nucleus, while the protoplasm forming the extreme outer boundary differs slightly from the rest, being more transparent, destitute of granules, and apparently somewhat firmer than the interior. We may also notice that at one spot a clear spherical space has made its appearance, but that while we watch it has suddenly contracted and vanished, and, after a few seconds, has begun to dilate so as again to come into view, once more to disappear, then again to return, and all this in regular rhythmical sequence. This little rhythmically pulsating cavity is called the "contractile vacuole." It is of very frequent occurrence among those beings which lie low down in the scale of life. We have before us a being which has arrested the attention of naturalists almost from the commencement of microscopical observation. It is the famous *Amœba*, for which ponds and pools and gutters on the house-roof have for the last 200 years been ransacked by the microscopist, who has many a time stood in amazement at the undefinable form and protean changes of this particle of living matter. It is only the science of our own days, however, which has revealed its biological importance, and shown that in this little soft nucleated particle we have a body whose significance for the morphology and physiology of living beings cannot be overestimated, for in *Amœba* we have the essential characters of a CELL, the morphological unit of organization, the physiological source of specialized function.

The term "cell" has been so long in use that it cannot now be displaced from our terminology; and yet it tends to convey an incorrect notion, suggesting, as it does, the idea of a hollow body or vesicle, this having been the form under which it was first studied. The cell, however, is essentially a definite mass of protoplasm having a nucleus embedded in it. It may, or may not, assume the form of a vesicle; it may, or may not, be protected by an enveloping membrane; it may, or may not, contain a contractile vacuole; and the nucleus may, or may not, contain within it one or more minute secondary nuclei or "nucleoli." Haeckel has done good service to biology in insisting on the necessity of distinguishing such non-nucleated forms as are presented by *Protamœba* and the other *Monera* from the nucleated forms as seen in *Amœba*. To the latter he would restrict the word *cell*, while he would assign that of "cytode" to the former.

Let us observe our *Amœba* a little closer. Like all living beings, it must be nourished. It cannot grow as a crystal would grow, by accumulating on its surface molecule after molecule of matter. It must *feed*. It must take into its substance the necessary nutriment; it must assimilate this nutriment, and convert it into the material of which it is itself composed. If we seek, however, for a mouth by which the nutriment can enter into its body, or a stomach by which this nutriment can be digested, we seek in vain. Yet watch it for a moment as it lies in a drop of water beneath our microscope. Some living denizen of the same drop is in its neighborhood, and its presence exerts on the protoplasm of the *Amœba* a special stimulus which gives rise to the movements necessary for the prehension of nutriment. A stream of protoplasm instantly runs away from the body of the *Amœba* toward the destined prey, envelops it in its current, and then flows back with it to the central protoplasm, where it sinks deeper and deeper into the soft yielding mass, and becomes dissolved, digested, and assimilated, in order that it may increase the size and restore the energy of its captor. But again, like all living things, *Amœba* must multiply itself, and so after attaining a certain size its nucleus divides into two halves, and then the surrounding protoplasm becomes similarly cleft, each half retaining one half of the original nucleus. The two new nucleated masses which thus arise now lead an independent life, assimilate nutriment, and attain the size and characters of the parent. We have just seen that in the body of an *Amœba* we have the type of a cell. Now both the fresh waters and the sea contain many living beings besides *Amœba* which never pass beyond the condition of a simple cell. Many of these, instead of emitting the broad lobe-like pseudopodia of *Amœba*, have the faculty of sending out long thin threads of protoplasm, which they can again retract, and by the aid of which they capture their prey or move from place to place. Simple structureless protoplasm as they are, many of them fashion for themselves an outer membranous or calcareous case, often of symmetrical form and elaborate ornamentation, or construct a silicious skeleton of radiating spicula, or crystal clear concentric spheres of exquisite symmetry and beauty. Some move about by the aid of a flagellum, or long whip-like projection of their bodies, by which they lash the surrounding waters, and which, unlike the pseudopodia of *Amœba*, cannot, during active life, be withdrawn into the general protoplasm of the body; while among many others locomotion is effected by means of cilia—microscopic vibratile hairs, which are distributed in various ways over the surface, and which, like the pseudopodia and flagella, are simply prolongations of their protoplasm. In every one of these cases the entire body has the morphological value of a cell, and in this simple cell reside the whole of the properties which manifest themselves in the vital phenomena of the organism. The part fulfilled by these simple unicellular beings in the economy of nature has at all times been very great, and many geological formations, largely built up of their calcareous or silicious skeletons, bear testimony to the multitudes in which they must have swarmed in the waters of the ancient earth. Those which have thus come down to us from ancient times owe their preservation to the presence of the hard, persistent structures secreted by their protoplasm, and must, after all, have formed but a very small proportion of the unicellular organisms which peopled the ancient world, and there fulfilled the duties allotted to them in nature, but whose soft, perishable bodies have left no trace behind. In our own days similar unicellular organisms are at work, taking their part silently and unobtrusively in the great scheme of creation, and mostly destined, like their predecessors, to leave behind them no record of their existence. The red snow plant, to which is mainly due the beautiful phenomenon by which tracts of Arctic and Alpine snow become tinged of a delicate crimson, is a microscopic organism whose whole body consists of a simple spherical cell. In the protoplasm of this little cell must reside all the essential attributes of life; it must grow by the reception of nutriment; it must repeat by multiplication that form which it has itself inherited from its parent; it must be able to respond to the stimulus of the physical conditions by which it is surrounded. And there it is, with its structure almost on the bounds of extremest simplification, taking its allotted part in the economy of nature, combining into living matter the lifeless elements which lie around it, redeeming from sterility the regions of never-thawing ice, and peopling with its countless millions the wastes of the snow land.

THE INDIVIDUALITY OF THE CELL.

But organization does not long rest on this low stage of cellular simplicity, for as we pass from these lowest forms into higher, we find cell added to cell, until many millions of such units become associated in a single organism, where each cell, or each group of cells, has its own special work, while all combine for the welfare and the unity of the whole. In the most complex animals, however, even in man himself, the component cells, notwithstanding their frequent modification and the usual intimacy of their union, are far from losing their individuality. Examine under the microscope a drop of blood freshly taken from the human subject, or from any of the higher animals. It is seen to be composed of a multitude of red corpuscles, swimming in a nearly colorless liquid, and along with these, but in much smaller numbers, somewhat larger colorless corpuscles. The red corpuscles are modified cells, while the colorless corpuscles are cells still retaining their typical form and properties. These last are little masses of protoplasm, each enveloping a central nucleus. Watch them; they will be seen to change their shape; they will project and withdraw pseudopodia, and creep about like an *Amœba*. But, more than this, like an *Amœba*, they will take in solid matter as nutriment. They may be fed with colored food, which will then be seen to have accumulated in the interior of their soft transparent protoplasm; and in some cases the colorless blood corpuscles have actually been seen to devour their more diminutive companions, the red ones. Again, there are certain cells filled with peculiar colored matters, and called pigment cells, which are especially abundant, as constituents of the skin in fishes, frogs, and other low vertebrate, as well as many invertebrate animals. Under certain stimuli, such as that of light or of emotion, these pigment cells change their form, protrude or retract pseudopodial prolongations of their protoplasm, and assume the form of stars or of irregularly lobed figures, or again draw themselves together into little globular masses. To this change of form in the pigment cell the rapid change of color so frequently noticed in the animals provided with them is to be attributed. The animal egg, which in its young state forms an element in the structure of the parent organism, possesses in the relations now under consideration a peculiar interest. The egg is a true cell, consisting essentially of a lump of protoplasm inclosing a nucleus, and having a nucleus included in the interior of the nucleus. While still very young it has no constant form, and is perpetually changing its shape. Indeed, it is often impossible to distinguish it from an *Amœba;* and it may, like an *Amœba*, wander from place to place by the aid of its pseudopodial projections. I have shown elsewhere that the primitive egg of the remarkable hydroid *Myriothela* manifests amœboid motions, while Haeckel has shown that in the sponges certain amœba-like organisms, which are seen wandering about in the various canals and cavities of their bodies, and had been until lately regarded as parasites which had gained access from without, are really the eggs of the sponge; and a similar amœboid condition is presented by the very young eggs of even the highest animals. Again, Reichenbach has proved that during the development of the crayfish the cells of the embryo throw out pseudopodia by which, exactly as in an *Amœba*, the yolk spheres which serve as nutriment for the embryo are surrounded and ingulfed in the protoplasm of the cells. I had shown some years ago that in *Myriothela* pseudopodial processes are being constantly projected from the walls of the alimentary canal into its cavity. They appear as direct extensions of a layer of clear, soft homogeneous protoplasm which lies over the surface of the naked cells lining the cavity, and which I now regard as the "Hautschict" or cortical layer of these cells. I then suggested that the function of these pseudopodia lay in seizing, in the manner of an *Amœba*, such alimentary matter as may be found in the contents of the canal, and applying it to the nutrition of the hydroid. What I had thus suggested with regard to *Myriothela* has been since proved in certain planarian worms by Metschnikoff, who has seen the cells which line the alimentary canal in these animals act like independent *Amœbæ*, and ingulf in their protoplasm such solid nutriment as may be contained in the canal. When the planaria was fed with coloring matter these amœboid cells became gorged with the colored particles just as would have happened in an *Amœba* when similarly fed.

THE SOCIETY OF CELLS.

But it is not alone in such loosely aggregated cells as those of the blood, or in the amœboid cells of the alimentary canal, or in such scattered constituents of the tissues as the pigment cells, or in cells destined for an ultimate state of freedom, as the egg, that there exists an independence. The whole complex organism is a society of cells, in which every individual cell possesses an independence, an autonomy, not at once so obvious as in the blood cells, but not the less real. With this autonomy of each element there is at the same time a subordination of each to the whole, thus establishing a unity in the entire organism, and a concert and harmony between all the phenomena of its life. In this society of cells each has its own work to perform, and the life of the organism is made up of the lives of its component cells. Here it is that we find most distinctly expressed the great law of the physiological division of labor. In the lowest organisms, where the whole being consists of a single cell, the performance of all the processes which constitute its life must devolve on the protoplasm of this one cell; but as we pass to more highly organized beings, the work becomes distributed among a multitude of workers. These workers are the cells which now make up the complex organism. The distribution of labor, however, is not a uniform one, and we are not to suppose that the work performed by each cell is but a repetition of that of every other. For the life processes, which are accumulated in the single cell of the unicellular organism, become in the more complex organism differentiated, some being intensified and otherwise modified and allocated to special cells, or to special groups of cells, which we call organs, and whose proper duty is now to take charge of the special processes which have been assigned to them. In all this we have a true division of labor—a division of labor, however, by no means absolute; for the processes which are essential to the life of the cell must still continue common to all the cells of the organism. No cell, however great may be the differentiation of function in the organism, can dispense with its irritability, the one constant and essential property of every living cell. There thus devolves on each cell or group of cells some special work which contributes to the well-being of all, and their combined labors secure the necessary conditions of life for every cell in the community, and result in those complex and wonderful phenomena which constitute the life of the higher organisms.

We have hitherto considered the cell only as a mass of active nucleated protoplasm, either absolutely naked or partially inclosed in a protective case, which still permits free contact of the protoplasm with the surrounding medium. In very many instances, however, the protoplasm becomes confined within resisting walls, which entirely shut it in from all direct contact with the medium which surrounds it. With the plant this is almost always so after the earliest stages of its life. Here the protoplasm of the cells is endowed with the faculty of secreting over its surface a firm, resisting membrane, composed of cellulose, a substance destitute of nitrogen, thus totally different from the contained protoplasm, and incapable of manifesting any of the phenomena of life. Within the walls of cellulose the protoplasm is now closely imprisoned, but we are not on that account to suppose that it has lost its activity, or has abandoned its work as a living being. Though it is now no longer in direct contact with the surrounding medium, it is not the less dependent on it, and the reaction between the imprisoned protoplasm and the outer world is still permitted by the permeability of the surrounding wall of cellulose. When the protoplasm thus becomes surrounded by a cellulose wall it seldom retains the uniform arrangement of its parts which is often found in the naked cells. Minute cavities or vacuoles make their appearance in it; these increase in size and run one into the other, and may finally form one large cavity in the center, which becomes filled with a watery fluid, called the cell sap. This condition of the cell was the first observed, and it was it which suggested the often inapplicable term "cell." By the formation of this central sap cavity the surrounding protoplasm is pushed aside, and pressed against the cellulose wall, over which it now extends as a continuous layer. The nucleus either continues near the center, enveloped by a layer of protoplasm, which is connected by radiating bands of protoplasm with that of the walls, or it accompanies the displaced protoplasm, and lies embedded in this on the walls of the cell. We have abundant evidence to show that the imprisoned protoplasm loses none of its activity. The *Characeæ* constitute an exceedingly interesting group of simple plants, common in the clear water of ponds and of slowly-running streams. The cells of which they are built up are comparatively large, and, like almost all vegetable cells, are each inclosed in a wall of cellulose. The cellulose is perfectly transparent, and if the microscope, even with a low power, be brought to bear on one of these cells, a portion of its protoplasm may be seen in active rotation, flowing up one side of the long tubular cell and down the other, and sweeping on with it such more solid particles as may become enveloped in its current. In another water-plant, the *Valisneria spiralis*, a similar active rotation of the protoplasm may be seen in the cells of the leaf, where the continuous stream of liquid protoplasm sweeping along the green granules of chlorophyl, and even carrying the globular nucleus with it in its current, presents one of the most beautiful of the many beautiful phenomena which the microscope has revealed to us.

IRRITABILITY OF PROTOPLASM.

In many other cells with large sap cavities, such as those

which form the stinging hairs of nettles and other kinds of vegetable hairs, the protoplasmic lining of the wall may send off into the sap cavity projecting ridges and strings, forming an irregular network, along which, under a high power of the microscope, a slow streaming of granules may be witnessed. The form and position of this protoplasmic network undergo constant changes, and the analogy with the changes of form in an *Amœba* becomes obvious. The external wall of cellulose renders it impossible for the confined protoplasm to emit, like a naked *Amœba*, pseudopodia from its outer side; but on the inner side there is no obstacle to the extension of the protoplasm, and here the cavity of the cell becomes more or less completely traversed by protoplasmic projections from the wall. These often stretch themselves out in the form of thin filaments, which, meeting with a neighboring one, become fused into it; they show currents of granules streaming along their length, and after a time become withdrawn and disappear. The vegetable cell, in short, with its surrounding wall of cellulose, is in all essential points a closely imprisoned Rhizopod. Further proof that the imprisoned protoplasm has lost by its imprisonment none of its essential irritability, is afforded by the fact that if the transparent cell of a Nitella, one of the simple water plants just referred to, be touched under the microscope with the point of a blunt needle, its green protoplasm will be seen to recede, under the irritation of the needle, from the cellulose wall. If the cellulose wall of the comparatively large cell which forms the entire plant in a Vaucheria, a unicellular alga, very common in shallow ditches, be ruptured under the microscope, its protoplasm will escape, and may then be often seen to throw out pseudopodial projections and exhibit amœboid movements. Even in the higher plants, without adducing such obvious and well-known instances as those of the sensitive plant and Venus's flytrap, the irritability of the protoplasm may be easily rendered manifest. There are many herbaceous plants in which, if the young succulent stem of a vigorously growing specimen receive a sharp blow, of such a nature however, as not to bruise its tissues, or in any way wound it, the blow will sometimes be immediately followed by a drooping of the stem commencing at some distance above the point to which the stroke had been applied; its strength appears to have here suddenly left it, it is no longer able to bear its own weight, and seems to be dying. The protoplasm, however, of its cells is in this instance not killed; it is only stunned by the violence of the blow, and needs time for its restoration. After remaining, it may be for some hours, in this drooping and flaccid state, the stem begins to raise itself, and soon regains its original vigor. This experiment will generally succeed well in plants with a rather large terminal spike or raceme when the stroke is applied some little distance below the inflorescence shortly before the expansion of the flower. In the several instances now adduced the protoplasm is, in the mature state of the plant, entirely included within a wall of cellulose. Some recent beautiful observations, however, of Mr. Francis Darwin, have shown that even in the higher plants truly naked protoplasm may occur. From the cells of certain glandular hairs contained within the cup-like receptacles formed by the united bases of two opposite leaves in the Teasel (*Dipsacus*) he has seen emitted long pseudopodia-like projections of the protoplasm. What may be the significance of this very exceptional phenomenon is still undetermined. It is probably, as Mr. Darwin supposes, connected with the absorption of nitrogenous matter.

UNIFORMITY OF PROTOPLASM.

That there is no essential difference between the protoplasm of plants and that of animals is rendered further evident by other motor phenomena, which we are in the habit of regarding as the exclusive attribute of animals. Many of the more simply organized plants give origin to peculiar cells called "spores," which separate from the parent, and, like the seeds of the higher plants, are destined to repeat its form. In many cases these spores are eminently locomotive. They are then termed "swarm-spores," and their movements are brought about sometimes by changes of shape, when they move about in the manner of an *Amœba*, but more frequently by minute vibratile cilia, or by more strongly developed flagella or whip-like projections of their protoplasm. These cilia and flagella are absolutely undistinguishable from similar structures widely distributed among animals, and by their vibratory or lashing strokes upon the surrounding water the swarm-spores are rapidly carried from place to place. In these motions they often present a curious semblance of volition, for if the swarm-spore meet with an obstacle in its course, it will, as if to avoid it, change the direction of its motion, and retreat by a reversion of the stroke of its cilia. They are usually attracted by light, and congregate at the light side of the vessel which contains them, though in some cases light has the opposite effect on them and they recede from it. Another fact may here be adduced to show the uniform character of protoplasm, and how very different are its properties from those of lifeless matter, namely, the faculty which all living protoplasm possesses of resisting the entrance of coloring matter into its substance. As many here present are aware, microscopists are in the habit of using in their investigations various coloring matters, such as solutions of carmine. These act differently on the different tissues, staining some, for example, more deeply than others, and thus enabling the histologist to detect certain elements of structure, which would otherwise remain unknown. Now if a solution of carmine be brought into contact with living protoplasm, this will remain, so long as it continues alive, unaffected by the coloring matter. But if the protoplasm be killed the carmine will at once pervade its whole substance, and stain it throughout with a color more intense than even that of the coloring solution itself.

THE MYXOMYCETÆ.

But no more illustrative example can be offered of the properties of protoplasm as living matter, independently of any part it may take in organization, than that presented by the *Myxomycetæ*. The *Myxomycetæ* constitute a group of remarkable organisms, which, from their comparatively large size and their consisting, during a great part of their lives, of naked protoplasm, have afforded a fine field for research, and have become one of the chief sources from which our knowledge of the nature and phenomena of protoplasm has been derived. They have generally been associated by botanists with the fungi, but though their affinities with these are perhaps closer than with any other plants, they differ from them in so many points, especially in their development, as to render this association untenable. They are found in moist situations, growing on old tan or on moss, or decaying leaves, or rotten wood, over which they spread in the form of a network of naked protoplasmic filaments of a soft creamy consistence, and usually of a yellowish color. Under the microscope the filaments of the network exhibit active spontaneous movements, which, in the larger branches, are visible under an ordinary lens, or even by the naked eye. A succession of undulations may then be noticed passing along the course of the threads. Under higher magnifying powers a constant movement of granules may be seen flowing along the threads, and streaming from branch to branch of this wonderful network. Here and there offshoots of the protoplasm are projected, and again withdrawn in the manner of the pseudopodia of an *Amœba*, while the whole organism may be occasionally seen to abandon the support over which it had grown, and to creep over neighboring surfaces, thus far resembling in all respects a colossal ramified *Amœba*. It is also curiously sensitive to light, and may be sometimes found to have retreated during the day to the dark side of the leaves, or into the recesses of the tan over which it had been growing, and again to creep out on the approach of night. After a time there arise from the surface of this protoplasmic net oval capsules or spore cases, in which are contained the spores or reproductive bodies of the *Myxomycetæ*. When the spore case has arrived at maturity it bursts and allows the spores to escape. These are in the form of spherical cells, each included in a delicate membranous wall, and when they fall into water the wall becomes ruptured and the little cell creeps out. This consists of a little mass of protoplasm with a round central nucleus, inclosing a nucleolus, and with a clear vacuole, which exhibits a rhythmically pulsating movement. The little naked spore thus set at liberty is soon seen to be drawn out at one point into a long vibratile whip-like flagellum, which, by its lashing action, carries the spore from place to place. After a time the flagellum disappears, and the spore may now be seen emitting and withdrawing finger-like pseudopodia, by means of which it creeps about like an *Amœba*, and like an *Amœba* devours solid particles by ingulfing them in its soft protoplasm. So far these young amœba-like *Myxomycetæ* have enjoyed each an independent existence. Now, however, a singular and significant phenomenon is presented. Two or more of these *Myxamœbæ*, as they have been called, approach one another, come into contact, and finally become completely fused together into a single mass of protoplasm, in which the components are no longer to be distinguished. To the body thus formed by the fusion of the *Myxamœbæ* the name of "plasmodium" has been given. The plasmodium continues, like the simple amœbiform bodies of which it is composed, to grow by the ingestion and assimilation of solid nutriment, which it envelops in its substance; it throws out ramifying and inosculating processes, and finally becomes converted into a protoplasmic network, which, in its turn, gives rise to spore cases with their contained spores, and thus completes the cycle of its development. Under certain external conditions the *Myxomycetæ* have been observed to pass from an active mobile state into a resting state, and this may occur both in the amœbiform spores and in the plasmodium. When the plasmodium is about to pass into a resting state it usually withdraws its finer branches and expels such solid ingesta as may be included in it. Its motions then gradually cease, it breaks up into a multitude of polyhedral cells, which, however, remain connected, and the whole body dries into a horny brittle mass known by the name of "sclerotium." In this condition, without giving the slightest sign of life, the sclerotium may remain for many months. Life, however, is not destroyed, its manifestations are only suspended, and if after an indefinite time the apparently dead sclerotium be placed in water it immediately begins to swell up, the membranous covering of its component cells becomes dissolved and disappears, and the cells themselves flow together into an active amœboid plasmodium.

CELL MULTIPLICATION.

We have already seen that every cell possesses an autonomy or independent individuality, and from this we should expect that, like all living beings, it had the faculty of multiplying itself, and of becoming the parent of other cells. This is truly the case, and the process of cell multiplication has of late years been studied, with the result of adding largely to our knowledge of the phenomena of life. The labors of Strasburger, of Auerbach, of Oscar Hertwig, of Eduard van Beneden, Bütschli, Fol, and others, here come prominently before us, but neither the time at my disposal nor the purport of this address will allow me to do more than call your attention to some of the more striking results of their investigations. By far the most frequent mode of multiplication among cells shows itself in a spontaneous division of the protoplasm into two separate portions, which then become independent of one another, so that instead of the single parent cell two new ones have made their appearance. In this process the nucleus usually takes an important part. Strasburger has studied it with great care in certain plant cells, such as the so-called "corpuscula" or "secondary embryo-sacs" of the Coniferæ and the cells of Spirogyra; and has further shown a close correspondence between cell division in animals and that in plants. It may be generally stated as the results of his observations on the corpuscula of the Coniferæ, that the nucleus of the cell about to divide assumes a spindle shape, and at the same time presents a peculiar striated differentiation, as if it was composed of parallel filaments reaching from end to end of the spindle. These filaments become thickened in the middle, and there form by the approximation of the thickened portions a transverse plate of protoplasm (the "nucleus plate"). This soon splits into two halves, which recede from one another toward the poles of the spindle, traveling in this course along the filaments, which remain continuous from end to end. When arrived near the poles they form there two new nuclei, still connected with one another by the intervening portion of the spindle. In the equator of this intervening portion there is now formed in a similar way a second plate of protoplasm (the "cell plate"), which, extending to the walls of the dividing cell, cuts the whole protoplasm into two halves, each half containing one of the newly formed nuclei. This partition plate is at first single, but it soon splits into two laminæ, which become the opposed bounding surfaces of the two protoplasm masses into which the mother cell has been divided. A wall of cellulose is then all at once secreted between them, and the two daughter cells are complete. It sometimes happens in the generation of cells that a young brood of cells arises from the parent cell by what is called "free cell formation." In this only a part of the protoplasm of the mother cell is used up in the production of the offspring. It is seen chiefly in the formation of the spores of the lower plants, in the first foundation of the embryo in the higher, and in the formation of the endosperm —a cellular mass which serves as the first nutriment for the embryo—in the seeds of most Phanerogams. The formation of the endosperm has been carefully studied by Strasburger in the embryo-sac of the kidney bean, and may serve as an example of the process of free cell formation. The embryo-sac is morphologically a large cell with its protoplasm, nucleus, and cellulose wall, while the endosperm which arises within it is composed of a multitude of minute cells united into a tissue. The formation of the endosperm is preceded by the dissolution and disappearance of the nucleus of the embryo-sac, and then in the midst of the protoplasm of the sac several nuclei make their appearance. Around each of these as a center the protoplasm of the mother cell is seen to have become differentiated in the form of a clear spherule, and we have thus corresponding to each of the new nuclei a young naked cell, which soon secretes over its surface a membrane of cellulose. The new cells, when once formed, multiply by division, press one on the other, and so combining into a cellular mass, constitute the completed endosperm.

(To be continued.)

THE DAVIS ISLAND DAM, PITTSBURG.

THERE is now rapidly approaching completion, just outside the city limits, a work of great interest, not only to Pittsburgers, but to every inhabitant of the Ohio and Mississippi valleys. The big Chanoine dam possesses the following claims over and above anything of the kind erected in this country. It will be, when completed, the *largest* lock and dam in the world; it is the *first* attempt to introduce the "movable" dam system in this country; it will have in operation the most powerful and perfect machinery ever put in a lock for emptying, working the gates, etc. Lastly, its construction has aroused intense opposition and has virtually divided Pittsburgers into two classes, dam-ites and anti-dam-ites.

Of the 350 men under Lieut. Mahan, the greater portion are at work upon the "shore" wall of the great lock. This is that part of the work which forms part of the shore (and bed) of the river at this point. The "channel," or river wall of the lock, is that which is now being begun. The shore wall comprises the following: The gate recesses, the water valves and devices for draining the lock, the machinery for opening and closing the gates, and the handsome brick building for the use of the lock operators, at present the home of the resident engineer and his assistants. The magnitude of the work may be inferred from the fact that over 11,000 cubic yards of cut stone and "rubble" (broken stone) are needed to complete the lock, and about 10,000 barrels of hydraulic cement are needed for masonry alone.

The lock, when finished, will be a small lake of a clear length of 600 feet between the gates and a clear width of 110 feet, and can hold 12 feet depth of water. The gates that shut off the water at either end of this lock are each in one solid piece, 118 feet long, 10½ wide, 14 high, and weighs 80 tons. The opening in the lower part of the gate recesses, and for filling and emptying the lock, are 4½ feet in diameter. The filling culvert, a lofty, arched water way, takes the water from these openings and conducts it to the lock, which is filled through 10 inlets, each 3 x 3½ feet, and 17 feet below the coping. The blocks of stone being hoisted on to the work are enormous, weighing several tons each. Yet the big cranes or "shears" pick up one of these as a man would reach for and pick up an orange.

The old system of lock-gates will not find a place in the Davis Island Dam. In this case the gates are drawn directly across each end of the lock, sliding back into the gate "recesses" in the shore wall, and when in position across the lock, resting on a shoulder built in the river wall. These gates will be ponderous affairs, and resemble a truss bridge laid on its side. Made of wood they will weigh eighty tons. They may possibly be constructed of iron, but this has not been decided as yet. The gates will not be needed until next spring or summer. To operate these big gates, ingenious machinery will be called into operation. Far down in the interior of the lock wall, a turbine water wheel—the most compact and powerful style of wheel—will be located. From it a shaft extends upward, and power and motion are thus conveyed to a shaft passing across the gate recess just over the gate. The latter rests upon fourteen iron wheels running on rails laid on masonry deep in the "recess." The shaft being rotated in the way described, a chain passing around it and attached to either end of the gate operates like a windlass and propels the whole affair either way desired.

"The gates *can* be closed and the locks *can* be filled (or emptied) in four minutes, but to be safe, I will say that seven minutes will be ample time for these operations," said Lieut. Mahan, in answer to an inquiry upon this point.

The only portion of the lock wall not ready for the capping is that at a point where the coffer dam gave way last winter. This was owing to the breaking of a "washer" in the lower portion of the coffer. Clay, etc., was dumped into the break, and the low stage of water helps matters at present. But a good deal of water comes through this point. A siphon pump keeps it down, and soon the massive blocks of stone will fill this gap and the entire well, 685 feet long, be completed. A Heald & Sisco centrifugal pump keeps the foundations at the lower end of the work drained, and pumps 7,000 gallons of water per minute.

Out in the river, over one hundred feet from present operations, men are busy inclosing the space wherein the river wall is to be built. At first it was decided to lay this wall upon a foundation of concrete, owing to the depth at which "bed-rock" was found; but more recently it was determined to get down to solid rock, even at a depth of seventeen feet below the river's present bed. The coffer dam now being built is an extension of the old one in use about the shore wall, and will be 15 feet wide, against 11 feet for the old one. Bed-rock having been laid bare, and the coffer completed, the water will be pumped up by a monster Heald & Sisco, that will throw 16,000 gallons per minute. Then "concrete" will be laid on the rock and this continued up some distance before the masonry begins. This concrete is formed of hydraulic cement, sand, and gravel. This hardens under water and becomes like stone itself. With the completion of this river wall the heaviest operations cease.

Another big job will be the laying of the foundations—entirely across the bed of the river—for supporting the sill of the dam and the series of movable "wickets," which comprise the most novel feature of the great dam. A detailed description of these is scarcely in place at this time, and a general account must suffice. The entire length of the dam will be 1,200 feet, and two stone piers divide this into three sections of 400 feet each. That section nearest the lock is called the pass, and this, besides the other two sections, is to be closed by the movable wickets whenever the stage of water in the river is less than 6 feet. This operation is made possible by the nature of the Chanoine system. Each "wicket" is a little dam by itself, hinged so as to lift up and oppose the water, or lie down and permit the river to flow over it. Each wicket is 13 feet long and 3 feet 8 inches wide, made of oak. They are to stand on end,

side by side, across the river, with a space between each of four inches. One by one they are raised, and when raised, the pressure of water above and a wrought iron prop below, retain them in rigid position until a "tripping bar" is brought into play and the entire dam falls down flat on the sill.—*Coal Trade Journal.*

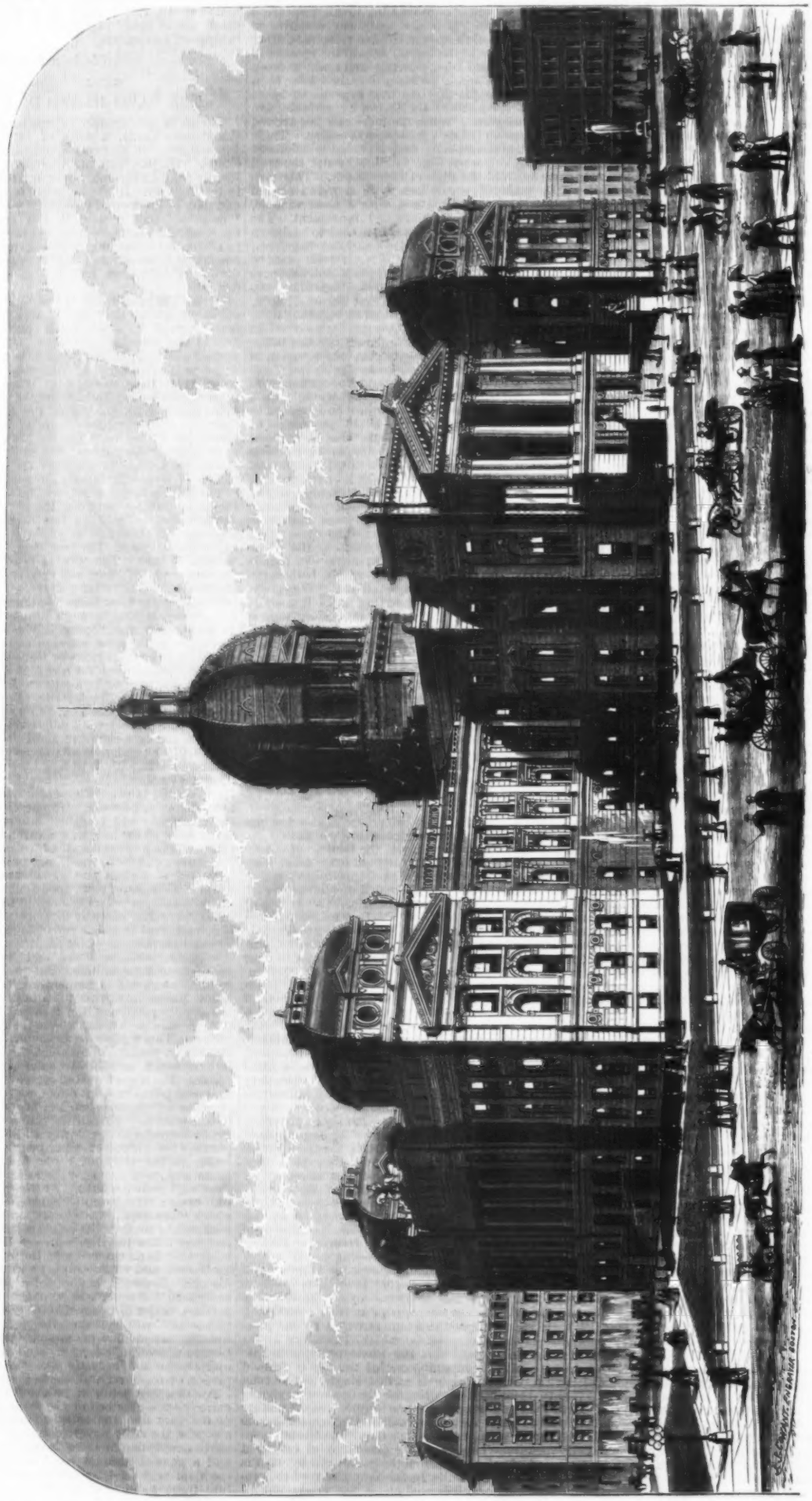
THE INDIANA STATE HOUSE.

THE accompanying fine illustration of the new Indiana State House, which we take from *Engineering News*, is from the designs of Edwin May, architect. The building is now under contract to be built in Indianapolis. When completed the structure will be one of the finest public buildings in the Union, an ornament to the capital city of Indiana, and we trust a lasting monument of credit to the skill and ability of the architect who designed it and who is to superintend its construction. The complete description of such an edifice may properly be deferred to its completion, and we propose here to give only its principal dimensions and a short description of its interior arrangement.

The dimensions are: South and north fronts, 185 feet; east and west fronts, 492 feet; center, east to west, 282 feet by 118 feet in width. Height of dome, 234 feet; diameter, 72 feet. Height of east and west fronts, 100 feet; south and north fronts, 92 feet. First story, 18 feet 6 inches. Second story, 19 feet. Representatives' hall, 48 feet. Senate chamber, 48 feet. Supreme Court room, 40 feet. Third story, 16 feet 6 inches.

The interior arrangement is as follows: The sub-basement will be used for heating and ventilating and the storage of heavy articles and fuel, and the basement will be divided into storerooms, vaults, and engine and boiler rooms. The basement will have a carriage drive from east to west, with an inside drive from center to north and south extremes. The entire business departments of the State will be on the first floor, which include offices for the Governor, Secretary of State, Auditor of State, Treasurer of State, Attorney General, Superintendent of Public Instruction, State Board of Agriculture, Clerk of Supreme Court, and Adjutant General. The Representatives' hall, 70x70 feet; court room, 50 feet 6 inches x 57 feet 6 inches; law library, 30 feet 6 inches x 56 feet 8 inches; library 44 feet x 56 feet 8 inches; and the library, museum, and reading room are all on the second floor, with numerous necessary antechambers, officers' rooms, committee rooms, water closets, wash rooms, etc.

The third story will contain 18 committee rooms, two



THE INDIANA STATE HOUSE.

joint committee rooms, public gallery to house—seating capacity, 296; standing room, 150; ladies' toilet room, two public water closets, public gallery to senate chamber—seating capacity, 408; standing room, 120.

From foundation to springing line of the roof the dome will be constructed of Indiana stone, and no plastering, stucco, or wood work will be allowed. The rotunda is well lighted and not obstructed with useless galleries, making noise and confusion, and serving to fill the air with dust from below. All the modern improvements will be called into requisition in ventilating and heating the building, and every room will secure the sunlight at some portion of the day. These special features regarding heat and ventilation were among the strongest recommendations of the plan, and conduced very largely toward its adoption. Each hall and room is lighted directly from the outside, all roof and ceiling lights being carefully avoided. The system of ventilation by exhausting the vitiated air from the floor line by means of the exhaust ducts, which are helped or forced by the steam pipes within, is most effectual, and the only safe and certain method of securing pure, fresh air, and is nothing more or less than the old fashioned fireplace method, the foul air passing up and out the chimney shaft, and the fresh air rushing in, even at the keyhole.

Mr. May's design was selected from a list of 24 competitors, by the Board of Commissioners, consisting of James D. Williams, President; John Love, Vice-President; Gen. T. A. Morris, Prof. John Collett, and Hon. I. D. G. Nelson, who decided only after a four months' critical examination of the competing plans.

The architect's estimate of the cost of the new capitol is $1,721,911.61, and the experts' estimate is $1,792,791.71. The cost of construction is limited to $2,000,000 by the State House act, and the Commissioners requested the architects to keep their estimates inside of $1,800,000.

The contractors for the erection of the building are Kanmacher and Denig.

DOVETAIL AND DOVETAIL TOOLS.*

Dovetail. (*Joinery.*) A flaring tenon adapted to fit into a mortise with receding sides, to prevent withdrawal in the

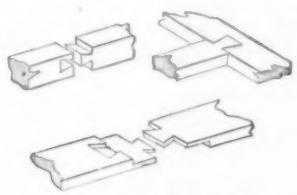


FIG. 1.—DOVETAILS.

direction of the tension it will be exposed to in the structure. The ancient Egyptians used dovetails of wood (*joggles*) to connect stones at the corners of their edifices.

a shows the ordinary dovetail with the parts detached; *b* the parts put together.

Concealed dovetails are made in two ways:

c d show the *lap-dovetail*, in which a fin of wood on the return edge hides the ends of the tenons and mortises.

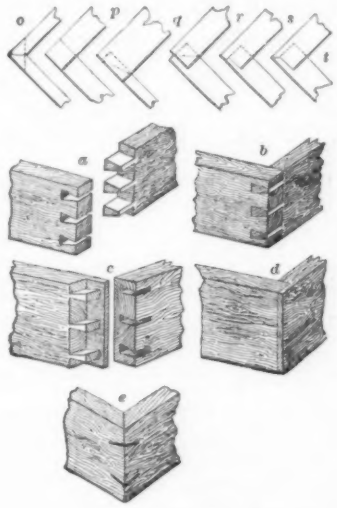


FIG. 2.—DOVETAILS.

e shows a miter-joint, locked by oblique keys of veneer. The ordinary *miter-dovetail* shows only a single line on the edge.

The series of illustrations to Fig. 2 show the several modes of dovetailing the edges of boxes and drawers.

o is a *miter* and *key* joint.
p, the common dovetail-joint.
q, the *half-lap* dovetail.
r, the *secret* dovetail.
s, the *lap*-dovetail.
t, the *miter*-dovetail.

Dovetail-box Plane. (*Joinery.*) A form of rabbet-plane for dressing dovetails.

Dovetail-cutter. A rotary cutter with a flaring bit used for boring dovetails.

Dovetail-file. A thin file with a tin or brass back, like the stiffener of a dovetail or tenon saw.

Dovetail-hinge. A hinge whose leaves are wider at their outer edges than at their hinging edges.

A hinge whose attaching portions are branching and divergent, like a swallow's tail.

Dovetailing-machine. A machine having a gang of chisels or saws for cutting dovetail-mortises or the kerfs therefor. In Fig. 4, the horizontal base supports a block, B, whose upper surface consists of two equally but oppositely inclined planes, B' B", whose slope corresponds with the chamfer of the desired dovetails. C C are standards guiding to a vertical path a gate, D, in which is fixed a series of chisels whose cutting-ends are at such an unequal elevation

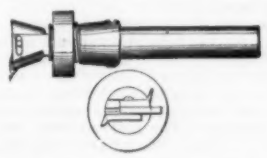


FIG. 3.—DOVETAIL-CUTTER.

as to correspond with the obliquity of the planes, B' B". These chisels are readily adjusted to any height and degree of separation, and are fixed to their proper positions by screw-bolts.

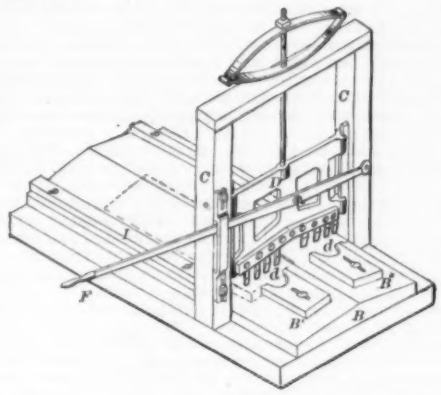


FIG. 4.—WHITE'S MORTISING DOVETAIL-MACHINE.

The gate is elevated and depressed by means of a lever, F, and is gauged or arrested in its descent by a stop or shoulder. Stops on the planes, B' B", gauge the stuff. I is a gauge for the edge of the stuff.

The board containing the heading-pins already sawed is placed on one of the inclines, B' B", and the chisels, being caused to descend, operate to excavate on one side the intervening stuff between the pins. The stuff being then placed on the other incline, and the gate again depressed, the excavation is completed by cutting away the opposite sides.

For excavating the mortises, the doubly inclined block, B, is removed, and another gate substituted for the gate, D, in which substitute gate the chisels are so secured as to have their lower ends in a horizontal line. The stuff being placed on the other incline, and the gate again depressed, the surplus timber is excavated at a single stroke.

In Fig. 5 is shown a machine in which the work is done by a gang of saws on a mandrel. The mortise-cutting portion is the right-hand part of the lower figure. In it

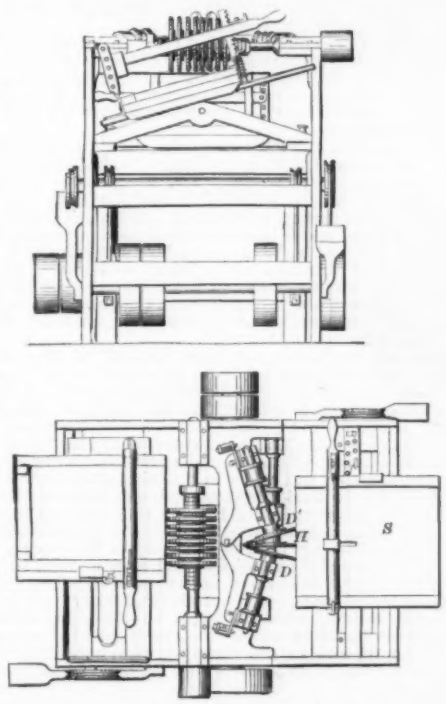


FIG. 5.—DOVETAILING-MACHINE.

the board is secured on the carriage, S, in such position that the edge of said board projects under the saws or cutters more or less, according to the depth that the dovetailing is to be cut, which will be governed by the thickness of the stuff. The board, on being properly adjusted, is then brought in contact with the saws by elevating the table, thereby carrying the board upward to the saws, D D', cutting the sides of the mortise, and of any angle that may be required, by adjusting the stays in which the cutters are hung to the required angle.

The central cutter, H, as will be seen, cuts into the board at a right line between the side saws, and as it leads in the cutting, the central portion of the mortise is cut away; the side saws, as they follow, cut away the remainder, leaving a clean, angular mortise for the admission of the tenon.

The tenoning portion is on the other side of the lower figure, and is also shown in end elevation in the upper figure. The board is secured with its end projecting over the edge of the carriage, to which it is clamped; the angle of the tenons being determined by the angle of the bed, as seen in the upper figure. The board and its bed are then raised to the cutters, one side of the tenons being cut at a time, together with a portion of the wood between them, which being done, the opposite side of the tenon is cut; and the remainder of the wood between them, by changing the position of the carriage.

Armstrong's dovetailing machine has two disks mounted on axes inclined to each other as well as to the main driving-shaft, one inclined to the right and the other to the left. Each disk has on its outer circumference a spiral groove, making one complete turn, into which is fitted a saw composed of segments, so arranged as in one complete revolution to give both the longitudinal and transverse cut necessary to finish a dovetail, one half being made by one disk and the other half by the other.

Other kinds operate by means of cutters, of form corresponding to that of the recesses to be made. The work is presented and fed on a table with the required adjustments.

Dovetail-joint. The junction of two pieces by means of splayed tenons and corresponding mortises of the respective parts. See *Dovetail.*

Dovetail-marker. A device for marking the dovetail tenons or mortises on the respective boards. The two plates of the frame are set at right angles to each other, and each has a scribing edge adapted to mark its side of the dovetail; one plate is adjustable to regulate the widths and distances,

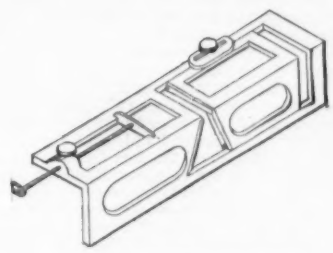


FIG. 6.—DOVETAIL-MARKER.

the adjustable gauge-plate affording a guide in setting the marker for the next scribe.

Dovetail-plane. (*Joinery.*) A side-rabbet plane with a very narrow sole, which may be made by inclination to dress the sides of dovetail tenons or mortises.

The side-rabbet plane may have an under-cutting bit with a flat lower edge, so as to conform to the shape of the mortise.

Dovetail-saw. 1. One for cutting the dovetail-tenon on the ends of boards; or cutting the dovetail-mortises in the faces or ends of boards to receive the said tenons. There are several varieties. One consists of a pair of circular saws running in planes, bearing such angular relation to each other as to give the required obliquity to the kerfs. In dovetailing-machines rotary cutters work to a given line, and also remove the material between the cheeks of opposite dovetail-tenons. Gangs of circular saws on a mandrel are constructed and arranged to do the same. (See Fig. 5.)

2. A small tenon-saw adapted for cutting dovetails. It has 15 teeth to the inch, and is usually about 9 inches in length.

3. A saw having two cutting edges, one at right angles

FIG. 7.—DOVETAIL-SAW.

to the other; one edge makes the side kerf, the other the bottom kerf.

* From "Knight's Mechanical Dictionary," Houghton & Osgood, Publishers, 21 Astor Place, N. Y.

THE AMERICAN SEAL FISHERIES, ALASKA.

A CORRESPONDENT of the Santa Barbara *Press* gives the following account of the method of catching seals at St. Paul's Island, Behring Sea: Sealing is *the* business of this people, and about the only one. Much wealth hath made the Pribylov seal hunter proud; he elevates the horn of his rejoicing, and looks with mingled pity and contempt upon his less fortunate brother of the Aleutian Isles.

Here the native shows a strong disinclination to perform any other labor than that of taking seal-skins; and no little work which he might get to do at ordinary wages is performed by outsiders, who have to be brought here for the purpose. This, however, is a good thing for the imported laborers, who come from the Aleutians or the mainland, and are generally very poor.

No great skill in hunting the seal is required; in fact, it is more like driving sheep, but hardly so difficult. I think the *vaqueros* who skirmish around after the wild, fleet flocks of Santa Cruz Island have a far harder task than do the sealers of the Pribylov Group.

The "drives" are made from the various rookeries, situated at distances of from one mile to eight miles from the village (except Northeast Point Rookery, which is twelve miles away, at the northern extremity of the island), and the seals are laboriously worked along, at the rate of only half a mile to a mile an hour, until the band or drove has reached the desired spot—the killing-ground near headquarters, the native village, and the salt-houses.

When a "drive" is to be made, the chief is notified, and informed of the number of men required for the purpose. These are selected, divided into gangs of twelve to sixteen, and each gang put in charge of a picked man, who is accountable to the chief or manager for the safety of the expedition.

The gangs usually start for the rookeries by 2 or 3 o'clock in the morning (it being broad daylight at the latter hour), or the night before, if the drive is to be a long one, in order to get well under way before the sun comes out, and not "worry the cattle."

Disturbing the breeding rookeries is carefully avoided; and this is rendered the more easy by the fact that the great

body of the killable seals—bachelors or "holluschikie"—are crowded and kept out of the harems by the heads of families, the powerful, polygamous old bulls, who probably number less than one-third of all the male seals.

The hauling-grounds reached (by "hauling-ground" is meant those stretches of sandy shore and rocky slope where the seals haul out of the water to rest, court, and sleep), the natives cautiously approach the mass of unsuspecting animals from the leeward side, and at a signal, rapidly run between them and the water, cut off escape, and turn their heads landward, when there is no difficulty about securing the whole band, for the dazed and unwieldy brutes will keep on the same course in which they are headed, and at the best can make but slow speed.

Seals are even more easily "bunched" than California sheep, and three men can easily drive five hundred. A *rodeo* of seals is nothing in difficulty to a California cattle *rodeo*.

The drove, numbering anywhere from five hundred to twenty five hundred, is then started for the killing ground, following their file leaders and in a close column "endways," as the untutored Confederate soldier called marching by the flank.

The movement of the fur seal on land is exceedingly awkward and laborious, and has been aptly described as "a kind of walking step and a sliding, shambling gallop;" the progression of the whole body is, by a succession of starts, made every few minutes, spasmodic and irregular.

The head is held well up, and the position of the animal's front is not unlike that of a noble mastiff lying down with head and ears erect. When fresh and perfectly cool, seals can make pretty fast time on smooth ground for a few minutes, but a quick-footed man can easily keep out of their way, unless he stumbles and falls, in which case he is a departed *Ursus lotor*, otherwise a "gone 'coon," for a big bull's incisors are very sharp and his shake too hearty by half.

If pushed and the day be warm or at all dry, they quickly show signs of fatigue, panting like a tired dog, though the tongue does not protrude, and many fall out of line, completely "flabergasted." At such times they show marked weakness in the posterior and tail, and drag themselves painfully along by the aid of the fore flippers alone. The animal is evidently deficient in strength in the lumbar regions, which accounts for his lumbaring gait.

Those that give out are struck in the head or nose by a stout hickory club in the hands of the native driver, knifed like a hog, and then skinned, as the pelt must be taken out at once in order to prevent its spoiling. The thin skull is easily crushed. The drove is thus worked slowly along to the killing-ground.

Arrived there the animals are herded until they have become cool and rested, when they are driven to the slaughter. Small bands or "pods"—fifty to a hundred and fifty in number—are cut off from the main drove, surrounded and huddled in a heap, when the strikers make for them with their clubs, hitting a head whenever they see it, except in the case of animals either too old or too young or otherwise unfit—such always get into the drove in greater or less numbers. These are released and permitted to escape to the water as soon as the struggling mass can be separated, the dead from the living. Killable seals are males of two, three, and four years old, respectively.

The first blow if well aimed stuns the animal, and a second puts him *in extremis*, so that he lies motionless, nearly, until the hunter can drag him out of the heap of dead and living, and with his long sharp knife thrust into the vitals, give him the *coup de grace*. The dead bodies are spread out on the ground, nearly touching each other, when the skinners come along and lay to, and the strikers go to the main drove for another "pod."

And so the work is kept up, going on so rapidly that forty or fifty men will drive, kill, and skin twenty-five hundred seals in a day, and knock off work at 2 P. M.

The operation of removing the skin is performed with wonderful skill and celerity. I know of nothing of the kind equaling it, unless it be the skinning of one California editor by another "for words spoken in debate." As now done, the work is accomplished as follows: The animal is first turned over upon its back, and a native, armed with a long, sharp knife, makes a swift cut through the skin, laying it open around the neck just behind the ears and from the lower jaw to the tail; then cutting about the flippers at their junction with the body, where the fur begins, the man leaves the carcass and goes on to another. He is followed by a second man, with a still sharper and finer knife, who rapidly cuts the skin loose from the body and peels it off. The presence of sand or grit in the animal's fur dulls the knife of the first operator, so that it is found better to have the operation performed by two men, each with a knife specially adapted to his particular part of the work. The whole operation is performed in from one to three minutes. It is hard work, trying on the back and muscles of the thighs, because of the continual stooping posture in which the worker has to maintain himself.

Following the seal-killers on the field come the "blubber-snatchers" and pelt-gatherers, two smaller gangs, each with a mule team, in which the plunder is hauled off to the salt-houses or to the steam oil works.

The blubber is of a dull yellowish white color, and all lies immediately under the skin. It is cut off, piled into the wagons, and sent to the boiling vats, where, under a tremendous fire, made of the same and a little wood, it sends up a thick smoke and a sickening odor that would offend the nostrils of a cast-iron buzzard. It produces an inferior oil, worth 25 to 35 cents the gallon, used principally for tanning and for adulterating whale-oil, not being a good lubricator.

When gathered, the skins are taken to the salt-house, put into bins, spread out in layers, fleshy side up, and thoroughly salted. In the course of a few weeks they are ready for bundling. Two skins are invariably put into each bundle, fur out, tightly rolled and strongly corded. In this shape they are ready for shipment.

The skins weigh about six, eight, and eleven pounds respectively, according to the ages of the animals—two, three, or four years.

The flesh of the fur seal is voraciously eaten by the natives; it makes a larger part of their meat food; they take it blubber and all, but the average civilized stomach recoils from this native tidbit. When carefully separated from the blubber, the meat is not unpalatable to a United States man. It is dark in color, tender enough, but has not the rich juiciness of our corn fed or grass fed beef. Four or five thousand "pups," or young seals, dressing ten pounds each, are annually killed by the natives of this island for food. They consider it doggoned good stuff. Those killed late in the fall are prepared for winter use by freezing in the open air. Thus prepared, the meat "keeps," when the weather is cold enough, which was not the case last winter.

Seal killing, when carried on by the hundred thousand, as it is on these islands, is bloody business, you see, but no worse than hog killing in Cincinnati. The way in which these nimble natives, headed by their chiefs, and superintended by a sanguinary *medico* from Massachusetts, will make away with a couple of thousand seals in half a day, would make a Cincinnati hog slayer go out behind his brown stone front and weep.

The vast numbers of carcasses, all grouped within small areas, make an immense aggregation of animal matter, which is left on the killing grounds to slowly decay under the action of this northern atmosphere. Were this a warm climate, I am sure miasma and consequent sickness would result from this vast mass of decaying animal matter left to rot and fester within gunshot of the native village, but, as it is, no ill effects appear to have ever followed the practice. There is, to be sure, a dense and massive odor filling the circumambient air in the fall, but, when carefully cut open by the natives with their keen edged knives, and passage ways made for the beleaguered garrison to escape to the brush, no trouble ensues.

The disposition of the carcasses, if they had to be hauled away, would of itself require the labor of half the people during the active season. Last year an effort was made to get rid of the carcasses of the seals killed in a certain spot—on a platform near the oil works—by dumping them into the waters of the cove, only a few rods distant. A short railway, with dump cars, was used for the purpose, and it was found that a dozen carcasess made a load—eight loads to the hundred, eighty to the thousand. Some five thousand carcasses were thus disposed of, requiring more than four hundred trips of the dump car. Carry this calculation to the 100,000 seals annually killed on these islands—80,000 on St. Paul's and 20,000 on St. George's—and you will have an idea of the amount of work it would require to get rid of all the carcasses. New spots for killing are selected from time to time, in order to get upon clean ground, the old grounds being left to "rest like an overworked grain field." These are again fit for use in the course of three or four years, the rank grass having almost completely covered the ground, so well fertilized by the rich deposits.

Let me return to my mutton (which is seal meat in this instance), or, rather, hide:

And right here I am constrained by a stern sense of duty to correct the popular notion that the color of the fur seal-skin is the same when worn by the animal as it appears after having left the furrier's hands. *Au contraire*, quite the reverse. Nor is the seal-skin sacque—that "perfect love" of a garment in the estimation of lovely woman, and for the want of which thousands of beauties "die," metaphorically, every winter all over fashion's domain—stripped from the animal's back all cut, made, and trimmed ready to encompass the beauteous form of milady. At least the breed of seals which grow sacques does not exist in these waters. When found, I'll make a note on't.

The seal-skin, as taken from its owner's body, is not attractive, and a novice would not suspect its value. The true fur is not visible, being concealed by an outer coating of hair, which, in the case of grown animals, is comparatively coarse and stiff, but quite soft and fine on the pups. This outer coating is nipped out of the pelt by the furrier, little by little, leaving only the down-like fur which gives the manufactured goods their great beauty and value—a value amounting to $100 or $150 for a finished sacque. The pelt then goes to the dye pot, where it receives that ravishing color which fashion approves, and the sight of which causes women to turn around in the street, look back, and groan with envy.

The prevailing color of the bulls' skins at this season, when dry, is a dull dirty brown, with a neck and shoulder covering of gray, or a dull steel mixed, shading off into a rufous-ocher on the breast and throat. Some specimens are nearly gray on the back, from head to tail.

The color of the cows when they come up out of the sea, wet and dripping, is thus described by Elliot, a close student of the seal life here, and I adopt his description, for the reason that the cows have only just begun to arrive this season, and I have not yet had an opportunity to study their appearance closely:

"They are of a dull dirty gray color, darker on the back and upper parts, but in a few hours the transformation made by drying is wonderful. You would hardly believe they could be the same animals, for they now fairly glisten with a rich steel maltese gray luster on the back of the head, neck, and spine, which blends into an almost pure white on the chest and abdomen. But this beautiful coloring is in turn altered by exposure to the weather, for in two or three days it will gradually change to a dull rufous-ocher below, and a cinerous-brown and gray mixed above. This color they retain throughout the breeding season, up to the time of shedding the coat in August."

While his coat is not handsome, the body of the seal is striking and finely formed, being lithe and supple in the highest degree, and though awkward on land, he is just the reverse when disporting himself in the water, his true element. His movement through the sea is by a succession of quick and energetic plunges and dolphin-like leaps, moving up and down with animation, and sometimes leaping clear out of the water, and while in the air turning the head quickly from side to side to catch a view of objects on land.

The great disparity in size between the male and female is remarkable. A full grown bull in good flesh—and this is when he comes up from the sea early in the summer to plant his "claim" for a seraglio—will measure from 6½ to 7½ feet in length from tip of nose to end of tail, and will weigh from 500 to 700 pounds, while the cows are only from 3½ to 4½ feet in length, and weigh but 100 to 150 pounds—often less than 80 pounds. They have shapely heads, attractive eyes, and an exceedingly gentle, intelligent, and amiable expression, as becomes their sex in the highest order of animals.

"Will not this precious race of fur-bearing animals soon be exterminated at the present rate of killing?" is a question which I have no doubt you have asked in your mind ere this.

I answer, no—not under the system of taking skins as now practiced here—no more than will the killing of ten or fifteen thousand wethers annually on a well conducted California sheep rancho (the San Julian, for instance) exterminate that race of animals in a particular spot.

It is the "bachelor" seals only—those under five years of age—which are killed. The cows and old bulls are carefully spared, and encouraged to be fruitful and multiply and to populate the sea with their kind.

The seraglios usually number fifteen cows to every bull, and it is estimated that as many as *one million pups* are born on this island every year, one-half of which are females, and that the whole seal life which finds its summer *habitat* here aggregates the enormous number of nearly *five millions of animals*. These estimates are probably too high, but who wants to be mean about half a million or so of seals?

I have to-day inspected a single rookery—Halfway Point—and see more than two thousand bulls hauled up on the rocks and sand beach over an interval of a mile or more, fighting for position, bellowing, spitting, and striking at each other, the strong driving the weak to the least favorable spots, and all making ready with might and main to corral the cows as fast as they come out of the water. It will readily be seen what a tremendous power of increase has been accumulated under this system of reproduction.

The taking of one hundred thousand skins annually from these surplus bachelors' bodies, which are killed for that purpose, does not interfere with the natural increase, there being left an ample number of heads of families to insure the enormous number of births which annually take place.

Herein is the secret of the interesting plan by which nature works out such wonderful results in the perpetuation and propagation of a precious animal life.

NORDHUNTER.

ROPINESS IN BEER.

THIS is caused by the development and multiplication of mucous bacteria, which are easily detected under the microscope on being magnified 500 times.

The fungus which, according to Pasteur, causes mucous fermentation, consists of small pellets, united to each other like the beads of a rosary, and having a diameter varying between $\frac{1}{1000}$ to $\frac{1}{1500}$ millimeter.

In fluids containing sugar and albumen they cause a separation, and (under the generation of carbonic acid) 100 parts sugar will equal nearly 51 parts mannite and 45·5 lactic acid gum.

If more gum than mannite is developed during fermentation, other and larger pellets may be observed, and Pasteur presumes that these are capable of converting the sugar solely into gum.

Ropiness, toughness, and softness of beer, by which the so-called mucous turbidness is produced, are nowadays of rare occurrence. The wooden surface coolers, which must be considered as the prime cause of this fatality, have generally been superseded by iron coolers, which may easily be cleaned, and prevent our beers from becoming ropy.

With the wooden coolers, even the most scrupulous cleanliness could not prevent the worts settling in the pores of the wood from undergoing a detrimental change, and this was more apparent as the cooler became older and more spongy, thereby permitting the worts to penetrate deeper into the wood.

The injurious influence exerted on the quality of the beer by an old cooler is apparent from a description by Kieselich, who purposely produced a so-called mannite beer. He says: "Accidentally, I had a splintery piece of wood from an old cooler. This I saturated with the first worts, and then put it in a warm place. When the worts were resting, I took a small quantity of them, placed the wood in it, and let the mass stand for half an hour. Then I boiled the worts with the hops, and, on cooling again, introduced the piece of wood, which, in the meantime, had been kept in a warm place. The worts had actually lost their fermentive power."

Beer that has become ropy or tough will no longer sparkle; on being racked it will form a twisted wiry jet, and appear as though albumen were dissolved in it.

As was previously remarked, this condition is caused by the so-called mucous bacteria, and will most generally result when the alcoholic fermentation has been disturbed—either by exterior or interior influence, as fluctuations in temperature, etc., or if the maltose be in disproportion to the other constituents (*i. e.*, non-sugar) and the nutritive elements of the yeast, as will be the case when starch sugar is employed.

Besides, mucous fermentation, according to Professor Dr. Lintner, will be greatly favored by the development of acetic acid, and the absence of a proper acidity.

Tannin checks the development of mucus without frustrating alcoholic fermentation, and, consequently, ropiness and the turbidness from mucous fermentation accompanying it will but rarely result in beers that are strongly hopped.

Habich recommends that such diseased beers be drawn from the yeast, and stored in chip casks containing ¼ to ½ freshening ("Krausenbier"). The casks are filled up to the bung, and must thoroughly ferment. After the lapse of a few days the evil will be overcome.

In connection with mucous fermentation, putrescent and butyric acid fermentation will often set in, both causing the beer to become turbid.

According to Pasteur, the latter is produced by an infusory worm—the "butyric acid ferment." The several individual parts of same are small cylindrical rods, rounded at the corners, generally straight, single, or in chains of two to four and more links. The average thickness is $\frac{1}{1000}$ mm.; the length of the single link comes up to $\frac{1}{10}$ mm.

They glide along with stiff body and faint undulatory motion. When they distend or move themselves, a quick trembling motion is imparted to the fore or hind part of their bodies. They propagate by means of separation. They may be sown like beer yeast, and will multiply in any medium favorable to their sustentation. They do not require oxygen for the support of their vitality, and the presence of same will even render them void of motion and life.

We make mention in this section of the fatal changes in beer, because the primitive cause of same is usually identical with mucous fermentation, and may solely be attributed to old wooden surface coolers.

Fortunately, wooden coolers are gradually going out of use, and very properly replaced by iron coolers. Accordingly, many diseases of beer, with which formerly we had so often to cope, are nowadays only known by name.

Wherever wooden coolers are yet employed the most scrupulous cleanliness is to be recommended; also the use of good varnish that will thoroughly close the pores of the wood, and thereby effectively check the penetration of the hot worts into the wood.—*Bohemian Brewer.*

FLEXIBLE NEGATIVES.

By A. W. TURNER.

THERE has long been wanting for many purposes in photography a reliable method of removing the negative film from the glass to an equally transparent, though flexible, support; and having, in the course of some experiments, discovered a simple method by which this result can be obtained, I hasten to make it known to your readers, trusting that they will give it a trial to find as much satisfaction in its use as I do myself. Without further parley I will proceed to describe my mode of working.

I take an ordinary varnished and retouched negative,

place it in a dish of cold water, and with it a piece of sheet gelatine about a quarter-inch smaller all round than the negative (a sample of which gelatine I inclose to the editor). Allow this to soak a couple of minutes, until slightly limp; take both out of the water together, and squeegee in a similar manner to ordinary carbon prints, with a piece of India-rubber cloth over it to prevent injury to the gelatine. Now put the negative, with gelatine attached, into another dish containing methylated spirits for a few minutes, to absorb as much of the water from the gelatine as possible. Stand it in a plate rack to drain, until it is surface dry, which will only take about five minutes or so; then coat with normal collodion, and stand up in a warm room till dry, which will be in the course of an hour or two, when, by gently raising the film with a penknife, it will entirely leave the glass, and you will have a flexible negative as transparent as when on the glass, which can be printed from either side.

I need hardly enlarge on the advantages of this class of negatives, and have only to remind photographers how they can be used for the single transfer carbon process without obtaining reversed images; they can be kept in books like ordinary paper prints, are easily cut, besides a host of other advantages too numerous to mention.

In addition, there is a great saving in expense, as the glass can be used over again as often as you like. Varnished negatives, however old, can be transferred by this means, except when they have been taken on albumenized glass; and even these, if they are only a few days old, are easily removed; but it appears from my experiments that old albumenized negatives become so attached to the glass by the coagulation of the albumen that they cannot be detached by this means; in fact, in one instance, the film actually split, one half coming off on the gelatine and the other remaining on the glass. This is my experience on this point, but I should like to have some of the results obtained by others with albumenized glass. With other negatives I find the method works without the slightest defect, and, in proof, inclose a few flexible negatives to the editor, one of which was taken at least five or six years ago.

I must confess I was rather surprised myself at the easy way in which the films can by this means be removed, and can only account for it by the fact that the gelatine when soaked in water expands so much that its contraction in drying is sufficiently strong to overcome the attraction of the collodion film to the glass, which, being in the slightest degree disturbed, of course leaves its original support. The methylated spirits I use to hasten the drying, and the collodion to prevent the gelatine curling up when it leaves the glass; without it the contracting power of the gelatine is so great that it drags the film from the glass before it is dry, and consequently spoils the negative.

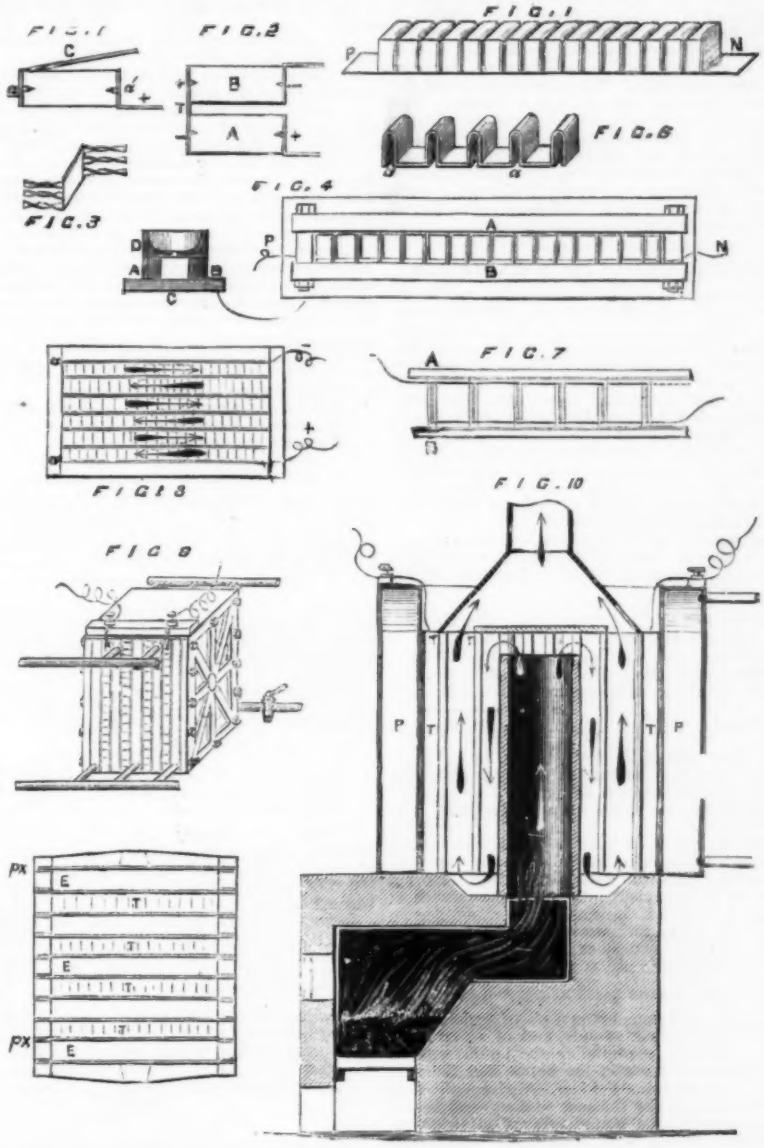
I only intend this as a short record of the result of my experiments; and this being now my busiest time, I am forced for the present to lay aside; but any further information on the subject I shall be happy to give your readers, if required, and trust that they will at least give this method a trial.—*Photographic News.*

NEW THERMO-ELECTRIC BATTERY.

THE invention of M. Sudre, of Paris, is as follows: In the construction of the thermo-electric couples and chains an isolated thermo-electric couple is ordinarily composed of a prism in metal or alloy. A, Fig. 1, and of a polar plate of iron, copper, German-silver, or other suitable metal, soldered to each of its extremities. The plates do not ordinarily interfere in the slightest with the electric force obtained, and it is the bar, A, such as that of antimony and zinc, which contributes in a great measure to the total effect produced. When it is desired to use two metals or energetic alloys, of which the effects are combined, and which are easily fusible, such as the bismuth and antimony, the couple is formed then of two bars, A and B (Fig. 2), which are joined together by a cross-bar, T, which binds them and is soldered to each. The total resistance of a couple is composed, 1st, of the resistance of the plate, C (Fig. 1); 2d, of the resistance of the bar, A, ordinarily formed of alloys sufficiently resistant; 3d, of a particular resistance at the points of contact or soldering, a, a^1, of the plates and of the bar. *Resistance of the Plate.*—The metallic plate should be of a metal sufficiently conductive, such as copper, iron, German-silver, or other composition, and sufficiently large and thick for presenting but a feeble resistance. It should have also the least length or unfolding possible, all conditions which are realized in the following description. *Resistance of the Bar.*—To obtain for the bar, A, very little resistance under a small volume, $\frac{L}{S}$ M. Sudre takes as starting point the formula $R=K\frac{L}{S}$, in which K is a specific coefficient for the matter employed; L, the length of the couple; and S, its section. As the resistance depends upon the relation $\frac{L}{S}$, one should in diminishing these two dimensions into the same relation diminish the volume of the couple without increasing its resistance. The length of the couple depends equally upon the differences of temperature employed, and is the greater as these differences are greater. For the differences of temperature from 10 to 120 degrees he gives to the couples a length of 10 to 12 millimeters, and for those of 300 degrees a length varying between 20 and 30 millimeters. *Resistance of the Solderings.*—In a short couple also the formation of the products of the points of contact or soldering is of the highest importance. The junction should be made so that the plate should be in contact with the points of the whole section of the bar, and at the same time penetrate to a very little depth in the bar, so as not to diminish too much the electromotive force of the couple; for the difference of temperature really effective is that of the temperatures of the two solderings, and this difference diminishes in degree as the plates penetrating deeper into the bars approach one another. To obtain this double object the extremity of the plates is cut in the form of a comb, the teeth of which are twisted upon themselves in such a manner as to present a helicoidal surface, which holds them, so to say, screwed into the metal. This cut portion is placed in the cast mould at the end of the bar in such a manner that the teeth are embedded in the casting. These teeth should be considered as the ramifications of the plate which are distributed on the whole section of the bar.

In the case where the couple is composed of two cast bars (Fig. 2), the cross-bar, T, will carry the comb to each extremity. Having thus explained the condition to be realized, and the means of realization in the construction of a thermo-electric couple, M. Sudre proceeds by a system of coupling the bars, as in a single cast of metal or alloy, so that the bars cast simultaneously are found bound and coupled together, and forming a flexible thermo-electric chain, easy to handle, facilitating the mounting of the apparatus, and realizing the minimum of resistance desired.

Fig. 3 represents the plate cut and bent twice at the time of using it for the formation of the couple. The center, G, is fixed, and the two bent parts are cut and twisted as described. On each side of the full part, G, of the plate is pasted with silicate of soda, or fixed by any other means, a thin plate of isolating substance capable of resisting the contact of the cast metal, such as paper of amianthus (or asbestos), mica, terra-cotta, or other suitable material. The mould (Fig. 4) is composed of a foot, C, of two side pieces, A, B, maintained parallel by two cross pieces of a cover, D, carrying a longitudinal furrow pierced with holes equal in number to the number of couples contained. The plates prepared as before described are placed in the mould between the two side pieces, A, B, as is represented in Fig. 4. Then, placing the cover, D, on the top and running in the cast alloy, the interior of the mould is filled, and the bent extremities of the plates are embedded in the cast metal. In taking the mould to pieces there is taken out a chain represented in Fig. 5, composed of as many elements as the length permits, which can be varied at pleasure, and this chain is found to be a thermo-electric battery, the extremities of which, P and N, are the poles. The paper of amianthus (or asbestos) may be used in various ways; it may be cut into strips, folded, and bent, as Fig. 6 indicates. The prepared plates are then placed in the slits, a, a, and the whole being placed in the mould, the cast of the metal will be in the form of a chain, analogous to that of the preceding case. In the case represented in Fig. 2, where the thermo-electric couple has been formed of two cast bars, A, B, the formation of the chain will be in an analogous manner. First of all the bars of metal the less fusible, those of A, for example, will be cast separately, and will carry at each extremity a cross bar, T, cut into a comb, as before described. Thus prepared, this first series of bars should be of the same form as the bent plate (see Fig 3), and will be conveniently placed in the moulds in lieu of the plates. The fusion of the second metal, B, in binding the open extremities of the cross-bars will form a thermo-electric chain composed of couples similar to those shown by Fig. 2.



Two metallic plates, A and B (Fig. 7), which are represented as planes, but which may be cylindrical or curved, are covered on one of their faces by a thin layer of isolating substance of electricity. This substance should be either a layer of enamel applied on the metal, or a leaf of mica if the temperature of the plate is elevated; or it may be a varnish, a leaf of vulcanized India-rubber, or a thin gummy or oily stuff if the temperatures employed are less elevated. Between these two isolated surfaces is placed one or more thermo-electric chains in such a manner that the extremities of the couples which constitute these chains press upon the isolating surfaces. When more chains are used side by side between the two same plates they should be returned each time in such a manner that the opposite poles of two contiguous chains are found side by side; they may be easily coupled in tension. Fig. 8 shows this arrangement, and the manner in which the current flows according to the directions of the arrows. The contiguous chains should be also isolated the one from the other by an isolating band, a, of amianthus (or asbestos) paper, mica, India-rubber, or other material. In the case where the surfaces, A and B, are curved, the space which is formed between two contiguous chains should be filled up with isolating matter, such as amianthus (or asbestos) paste, to avoid the lateral loss of caloric; all the elements of the chains are electrically isolated by the isolating thickness of the plates, but they are not isolated calorically, so that if by any means the plate, A (Fig. 7), is maintained at a high temperature, and plate, B, at a lower temperature, the caloric will flow across the isolated beds and penetrate the couples, across which it will continue its course from one soldering to the other. The difference of temperature between A and B will be within very little of the temperature between the solderings of the couples. As long as A and B keep their respective temperatures a thermo-electric current will be furnished by the battery formed by the chains, and will be collected as shown by Fig. 8. The plates, A and B (Fig. 7), form part of two systems having for their object: one, the "collector," to collect and store the necessary caloric for the consumption of the system, A, B; the other, the "diffusor," to take up at B the caloric received from A across the battery, and to disperse it or convey it to another point.

When the plate, A (Fig. 7), is heated either by steam which is condensed by its surface, or by a hot liquid in circulation, the quantity of heat yielded to the plate, A, upon its surface is sufficient for the consumption of the battery. The plate, A, in this case is its proper "collector," but it cannot be so if the apparatus is heated by heated gases or air. The simple circulation of the heated gases upon the plate, A, is not sufficient to maintain it at the desired temperature, and the plate receives its heat by a metallic system which presents a very large surface to the gases in motion, and causes them to travel over a course sufficiently long so that they abandon the greater part of their caloric. These "collectors" may vary in form and dimensions according to the case, but they are always collected into one combination of metallic pieces ordinarily of cast iron, so that they present by their combination a series of flues through which circulate the gases, and are formed with ribs, as desired, for directing the flow of the caloric against the plate, A (Fig. 7). M. Sudre has devised several ingenious forms of apparatus for supplying the required heat, but the principle being explained, it will be sufficient if we illustrate two, showing the construction of a liquid and dry heat converger. It is obvious that the "diffusor" may take the form of an envelope, through which cold water flows, or it may be an arrangement of radial plates of metal of high conducting power, such as copper. Where dry heat is used, as, for instance, from the combustion of fuel, the diffusor may with advantage take the form of a water envelope, the water passing through which, partially warmed by the heat abstracted from the plate, B (Fig 7), can be raised to a high temperature by the gases escaping from the flue of the furnace, and thus be utilized as a liquid medium for supplying heat to another generator—attaining possibly the maximum economy. Similarly it is obvious that the heat employed may be obtained from the waste gases of a furnace used for other purposes.

Fig. 9 represents in perspective, elevation, and section respectively, a thermo-electric battery heated by steam or other hot fluid. The apparatus is formed by the superposition of frames pressed between two pieces of cast iron by a

series of bolts which cross it. Between these frames are equally pressed ten copper plates, *p*, which serve to divide the box thus formed into nine compartments. Four of these compartments, T, are filled by a series of thermo-electric chains, such as those seen in Fig. 7, compressed between the two plates, *p*, from which they are isolated, as also the frames which surround them, by some sheets of India-rubber. The extremities of this system of thermo-electric coupled chains terminate by some lengthened polar appendages which jut out across the frame from which they are isolated to give up the current. Two of these compartments, V, are designed to receive the steam at any pressure whatsoever, and the three others, E, E, E, a current of escaped water. Between the frame and the two plates which form this compartment is a joint of India-rubber, which renders the compartment water-tight. These frames are provided with elbow pipes, to which are jointed pipes, serving some as the inlet to the steam, others the inlet of the water, and others for the outlet of the water and the expulsion of the condensed steam. Each frame carries thus two elbow pipes, one for the arrival, the other for the outlet. In the water-boxes are placed two ribs, which serve to intertie the plates, *p*, so as to lengthen the course taken by the water. This apparatus realizes, therefore, four thermo-electric batteries on the system, of which the poles abut on bars carried by a small board fixed on the apparatus. The dimensions and number of compartments to the apparatus above described may be varied at pleasure. It may, therefore, be considered as a specimen of all those which can be constructed upon the principles before described and designed to work by the heat of steam. Fig. 10 represents an apparatus heated by hot gases, and more ordinarily by the heated air proceeding from a special fire-grate arranged on every side, consuming any combustible whatsoever; G, collector, T, T, thermo-electric chains applied against the collector, from which they are electrically isolated; these chains are bound between them by solderings or other connection. The current rises and descends alternately through two contiguous chains. The apparatus may consist of either a single or several distinct batteries. P represents the water-boxes of cylindrical sections, which are applied upon the exterior surface of the thermo-electric chains with which they are electrically isolated; these boxes constitute the water "diffusor," which obviously can be replaced by a dry "diffusor" consisting of radial plates of metal of high conductive power.

SMALL ELECTRIC LIGHTS FROM BATTERIES.

EXCEPTING in courses of physical science, the use of the battery for the production of the electric light by means of regulators is almost completely given up. Experience has at the present day decisively established the superiority of machines from the point of view of the cost of working.

Still, there are many persons who think of employing the battery for the production of small lights, more especially with lamps constructed for incandescence. With 6 or 8 flat Bunsen cells, 20 centimeters in height, costing at present 12 fr. each, or 96 fr. for the maximum, it is possible to maintain during three hours a light equal to from 8 to 10 carcel burners (*becs*). Such a result, however tempting it may be to the amateur, does not afford grounds for the use of the battery in industrial applications.

The following figures leave no doubt as to this matter.

Expense of a Bunsen battery, Ruhmkorff model, of 8 elements. Luminous intensity, 10 *becs*. Duration of the light, 4 hours at the outside.

Nitric acid, 4 kilog	3fr. 20c.
Sulphuric acid, 1 kilog. 200 gr.	0fr. 36c.
Mercury, 100 gr	0fr. 60c.
Zinc (waste included), 400 gr	0fr. 40c.
Maintenance, breakage, mounting, etc.	1fr. 20c.
Total	5fr. 81c.

Or 1fr. 45c. per hour, and per *bec* per hour 0fr. 14·5c.

We must not forget that the Bunsen battery is most disagreeable to use, in consequence of the production of nitrous gases, which poison the air and act upon everything they come into contact with.

The only batteries which have to be considered besides that of Bunsen are: Bichromate batteries, successfully used in electro deposition; Thomson batteries, recently imported from England, by M. Niaudet, and experimented with at the Collége de France by M. Mascart, for working electro-magnetic machines; the Faure battery, a kind of modified Bunsen; lastly, the rotary battery of Becquerel, well known to physicists, although not in use.

THE FAURE BATTERY.

This is composed of a porous bottle made of agglomerated graphite, closed with a carbon stopper, and of an ordinary cylindrical zinc element, surrounding the bottle without touching it. Nitric acid is put in the bottle, and the zinc is surrounded with acidulated water. The couple thus mounted acts like an ordinary Bunsen, without sensible evolution of nitrous gases;* but the production of electricity is very weak. Eight couples, carefully mounted, were unable to raise to incandescence the end of a carbon rod 1 millimeter in diameter.

THOMSON BATTERY.

The battery experimented with was composed of 12 couples, of which the zinc and copper surfaces were 200x200 millimeters. The electrodes and the liquids were separated by a square tray of parchment paper, and by wooden blocks about 4 mm. thick.

These 12 couples attached to an incandescent lamp with carbons 1 mm. in diameter gave a white but extremely weak light (? 1 candle). The internal resistance must, therefore, be very great, in spite of the size and proximity of the electrodes.

We calculate that, in order to obtain a current equivalent to that from the 8 Ruhmkorff couples, at least 45 Thomson couples on the model we used would be required, which would be expensive to purchase and somewhat cumbersome.

The expense for 4 hours would be about:

Zinc (including waste), 700 grammes	0fr. 70c.
Sulphate of copper, 1 kilo. 500 gr.	1fr. 65c.
Maintenance (porous trays, etc.)	0fr. 35c.
Mounting and unmounting (partly covered by the reduced copper)	0fr. 30c.
Total	3fr. 00c.

Say 7fr. 5c. per hour per *bec*.

* We should say that it acts very *unlike* an ordinary Bunsen, and much more economically; the gas evolved being mainly N_2O_3 instead of N_2O_4.—*Ed. S.*

This battery is very constant, emits no odor, and could work for over 12 hours without being recharged. On the other hand, its first cost is high, and it is cumbersome. Although more economical than the Bunsen, its expense is still too great to allow of its being utilized for currents in electric lighting.

BICHROMATE OF POTASH BATTERIES.

A trough battery of 15 couples (5 in series and 3 for quantity), designed by M. Ducretet and M. Lo'seau, did not give good results. The light, tolerably vivid at the moment of immersing the elements, almost immediately began to fall off. At the end of ten minutes considerable polarization had occurred, reducing the light to about ⅓ *bec*. By withdrawing the couples from the fluid they become almost instantaneously depolarized. Agitating them within the fluid produces a partial depolarization which allows of the experiment being continued longer than when they are at rest.

This battery, costly, cumbersome, and very inconstant, could be used only for experiments of very short duration.

BATTERIES WITH POROUS VESSELS.

Eight Ruhmkorff couples were tried with the following exciting fluids in succession:

1. Le Gourant de Tromelin element.

Interior vessel (carbon), acid bichromate solution. Exterior vessel (zinc), solution of chloride of ammonium (sal-ammoniac).

2. Poggendorff element.

Interior vessel (carbon), acid bichromate solution. Exterior vessel, acidulated water.

The De Tromelin battery is superior to that of Poggendorff.

1. It emits no odor; the zincs are consumed regularly; there is no effervescence.

2. The depolarizing fluid becomes exhausted in two hours; the capacity of the interior vessel being about 35 centiliters.

3. It would be necessary to increase threefold (in quantity) the number of couples in order to obtain a result equal to that of the Bunsen battery, which lasts during four hours.

4. The same battery mounted with fluids No. 2 gave inferior results: the zinc is consumed less regularly, there is a little effervescence. The substitution of a saturated solution of sal-ammoniac for the acidulated water is therefore advantageous.

5. In order to replace the Bunsen battery by that with bichromate and sal-ammoniac solutions, it would be necessary, first, to increase the number of couples connected for quantity, or to augment the surface; and, secondly, to increase the relative capacity of the carbon department.

EXPENSE OF A LE GOURANT DE TROMELIN BATTERY OF 24 COUPLES, CONSTRUCTED TO WORK FOR 4 HOURS.

Sal-ammoniac, 1 kilog.	2fr. 50c.
Zinc (including waste), 300 grammes.	0fr. 30c.
Bichromate of potash, 2 kil.	4fr. 80c.
Maintenance, mounting, etc.	1fr. 25c.
Total	8fr. 85c.

or, say, 22c. per hour per *bec*, an expense which is far too great. The advantage of dispensing with nitric acid is compensated by the necessity of increasing threefold the number or the surface of the couples.

ROTARY BATTERY.

A battery of 12 circular zinc-carbon couples, 14 centimeters in diameter, immersed to a depth of about 2 centimeters, gave only insignificant results when the fluid in which they were immersed was water or a solution of sal-ammoniac.

With acid bichromate solution the results were remarkable. The zincs were amalgamated, and the velocity of rotation was 80 revolutions per minute.

Composition of the fluid:

Water	6 kilog.
Sulphuric acid	1 kilog. 200 gr.
Bichromate of potash	0 kilog. 500 gr.

At starting the battery lit up tolerably effectively 2 incandescence lamps with carbons 2 millimeters in diameter; afterward, more effectively, a single lamp. The experiment lasted during 45 minutes; at the end of this time the fluid was exhausted.

It would be necessary to use 8 couples in order to maintain a lamp giving a light equivalent to about 4 *becs*.

In order that the couples should last during 4 hours, the capacity of each trough should be 3 liters. The total expense in 4 hours would be:

Sulphuric acid, 2 kilog. 800 gr.	0fr. 85c.
Bichromate, 1 " 700 "	4fr. 05c.
Zinc (including waste), 300 "	0fr. 30c.
Mercury, 50 "	0fr. 30c.
Mounting and unmounting	0fr. 20c.
Total	5fr. 70c.

By doubling the surface of the carbon electrode, a light of about 8 *becs* would be obtained. The expense per hour and per *bec* would be about 18c.

Thus the disk battery, more convenient than any other when it is properly worked, must also be rejected on account of its high price and considerable expense in working.

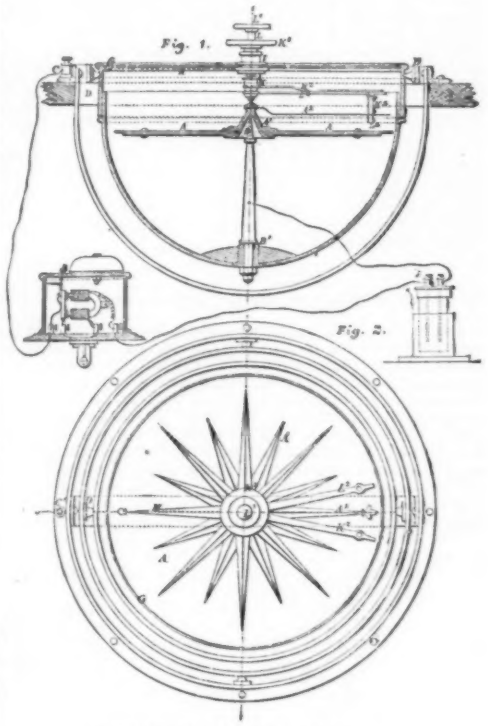
We will mention, only with a view of recording them, some experiments made by amateurs with telegraph batteries. More than 200 large-sized Leclanché couples, or more than 300 Calland couples, properly connected up, would certainly be required in order to obtain a small light.

The result of these investigations is therefore an absolute condemnation of the voltaic battery from the point of view of the production of the electric light, whenever an illumination continued for many hours is required.—*Revue Industrielle.*

THE ELECTRICAL ALARM COMPASS.

A VERY ingenious apparatus for reducing the risks of navigation has recently been devised by Mr. Henry A. Severn, of Herne Hill, and which is illustrated in the accompanying engraving. It consists of an ordinary mariner's compass placed in connection with a small battery, and so arranged as to enable the captain or officer in charge of a ship to at once detect when she is off her ordered course. It is placed in the captain's cabin, and having, on quitting the deck, given his orders as to the course to be steered, he is enabled by the ear alone to detect any departure from his instructions. In designing this compass, Mr. Severn utilized the constant position of the card, and the ever-varying position of the ship for the purpose of making and breaking metallic contact. A pair of index hands placed above the compass card can be adjusted to any angle, the one hand to port and the other to starboard of the direct course, thus allowing for a given amount of deviation to one side or the other. If the ship is steered off her course beyond the limit thus allowed on either side, an alarm bell instantly rings, and will continue to ring until the right course is resumed. In our engraving, Fig. 1 is a section and Fig. 2 a plan of the compass, with its accessories, the battery and bell. In practice these several parts are placed together in a small box, which is easily carried about, and can be placed in any part of the ship.

Referring to our engraving, L^1 and K^1 are two flat brass milled heads of such size as to admit of being conveniently turned about their centers by the fingers. These milled heads are on the upper surface of the glass lid of compass, and are themselves severally attached to the rod, L, which passes through and rotates within the hollow tube, K, which is attached to the milled head, K^1. Both the movable heads pass through the socket, I, which is cemented to the glass lid. The milled heads can be made to revolve within the socket, I, and the head, L^1, rotates in either direction within K^1. The socket, I, is placed in metallic communication with the rim of brass around the lid by means of the covered wire, G H. Under the glass lid, and attached respectively to the terminations of L and K, are fixed the two metal index hands, K^2, L^2. At the ends of these hands are suspended platinum wires, K^3, L^3, which are therefore in metallic contact with the brass rim, G, and connecting screw, C. The metal point for suspension of the card is insulated from brass bowl at B^1, and is connected with one pole of a low and constant battery cell. Mr. Severn prefers to give the card two magnetized needles, and not in contact with the metal cone for suspension. B B^1 is the metal point, A^1 the brass center, and A A the card. Attached to the top of the brass center, A^1, is a light metal arm, A^2, the end of which is made of platinum for a length of one inch. This metal arm is therefore in metallic communication with the wire, C, attached to the pole of the battery. To complete the circuit all that is necessary is to bring one of the hanging wires, K^3 or L^3 (either will do), into contact with



ELECTRIC ALARM COMPASS.

metal arm, A^2, and if an electric bell is placed in the circuit it must ring whensoever the contact is made. Availing himself of the ever stationary position of the compass card, and the constantly moving vessel, as we have pointed out, Mr. Severn is enabled so to adjust the index hands and their hanging wires, K^3, L^3, as to bring them respectively to any required distance on either side of the metal arm, A^2, and so long as the vessel does not vary her course (so as to bring one or other of the wires, K^3 or L^3, into contact with A^2), no alarm bell can ring. If, however, that distance is reached or exceeded, the bell will immediately ring, but will stop so doing if error in steering or movement is retraced. It will continue to ring if the variation continues, because the hanging wires, K^3, L^3, are heavy enough to overcome the strength or polarity of the card and its needles. The captain or officer using this compass has merely to adjust the index hands by means of the two milled heads, to any angle he pleases, after the vessel is in her course, and in heavy or fine weather, by night or by day, the alarm bell rings when the steering is bad. The milled heads can be raised up ½ inch through the socket, I, and the hanging wires are then free of the metal arm, A^2, and the compass in all respects becomes an ordinary one.

It will thus be seen that by the aid of this compass the captain when below can ascertain, without any trouble to himself, when the steering is bad, or the vessel is taken out of her ordered course by night or day. It will lead to better steering, inasmuch as both officers and men on deck will be aware that the captain has a check on them below. Another important point is that it will give intimation at night in harbor when the vessel alters her position by swinging around her anchors. In short, the tell-tale compass appears to be well calculated to aid in lessening the risks and dangers of both coast and ocean navigation generally.—*Engineering.*

CARNELLAY has compiled a table which shows that, with five exceptions, the coefficient of expansion of the elementary bodies increases as their melting point sinks. The exceptions are arsenic, antimony, bismuth, tellurium, and tin.

ELECTRIC VOTING APPARATUS.

THIS apparatus is an invention of Count Anton Roncalli, a member of the Italian Parliament. It is intended to be of service in assemblies, parliaments, etc., as it simplifies voting, permits of the members voting without being obliged to leave their seats, and saves time, as 300 votes can be cast in a minute. Each member's desk is provided with a small wooden box containing a commutator, *a*, and two contacts, *b* and *c*, *b* signifying "yes," and *c* "no." (Fig. 2.) The commutator is connected with the battery and the contacts are connected with metal strips, one for each contact. These strips are arranged on a table in two rows opposite the

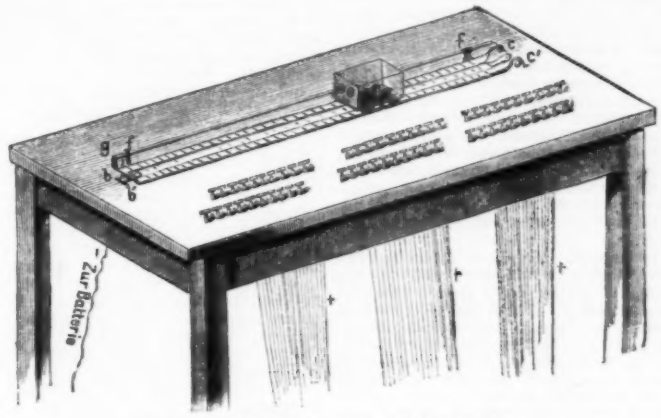


FIG. 1.—ELECTRIC VOTING MACHINE.

corresponding names of the members, all the negative strips being on one side and the affirmatives on the other (Fig. 2). Every contact must necessarily have an independent connection with its corresponding strip, as is shown in Fig. 1. Metal rails are attached to the table at each side of the rows of metal strips, and upon these rails a small car, consisting of an isolated plate, A (Fig. 2), provided with four wheels and the electro magnets, B B, for the negative votes, and C C for the affirmatives, can pass up and down. These electro magnets are connected with a metal band, *e*, gliding on a rod, *f*, parallel to the rails, and so arranged that when the car is drawn forward it will strike the contact, *g* (Fig. 1), to which the wire from the battery is attached, and close the current. Before the votes are taken the car is at the end, *c c*¹, of the table. The members then place the commutator, *a*, against one of the contacts, *b* and *c*, according to the vote they wish to cast, and leave it in that position. The car is then drawn from *c c*¹ to *b b*¹ (Fig. 1), by means of a clockwork or string, and all the votes will be recorded on a sheet of paper placed between the two rows of strips. The apparatus operates in the following manner. If, for instance, the third member on the list, Mr. Rossi, has voted in the affirmative, the current will pass from the battery to the commutator, from there to the metal strip on the affirmative side corresponding to Mr. Rossi's name, thence when the car passes, into the spring, *d*, which glides over the metal strips, and then into the electro magnet, C C, to which *d* is attached. The magnet draws its lever downward, and this in turn moves the dial above it the distance of one tooth, and presses the punch, *h*, on to the sheet of paper containing the names, and either punches out a piece of it or leaves some other mark on the affirmative side opposite the name of Rossi, as is shown in Fig. 2. The negative magnet acts in the same way, but both cannot operate at the same time. As soon as the car has passed over its course the sheet of paper is removed, a new one introduced, and an attendant goes to each desk and presses on to the knob, *h* (Fig. 2), which causes the commutator to assume its neutral vertical position, so that the apparatus is ready for a new vote. In case a secret vote is desired, the sheet containing the names is omitted, and the number of votes cast can be seen on the dials, which are turned the distance of one tooth for each vote. To prevent fraudulent voting the wires are so arranged that the current will not be closed unless a weight of at least 100 pounds rests on the chair; that is, the member must sit on the chair in front of his desk or his vote will not be recorded. Blanks on the name sheet indicate that the member was absent or declined to vote.—*Neueste Erfindungen und Erfahrungen.*

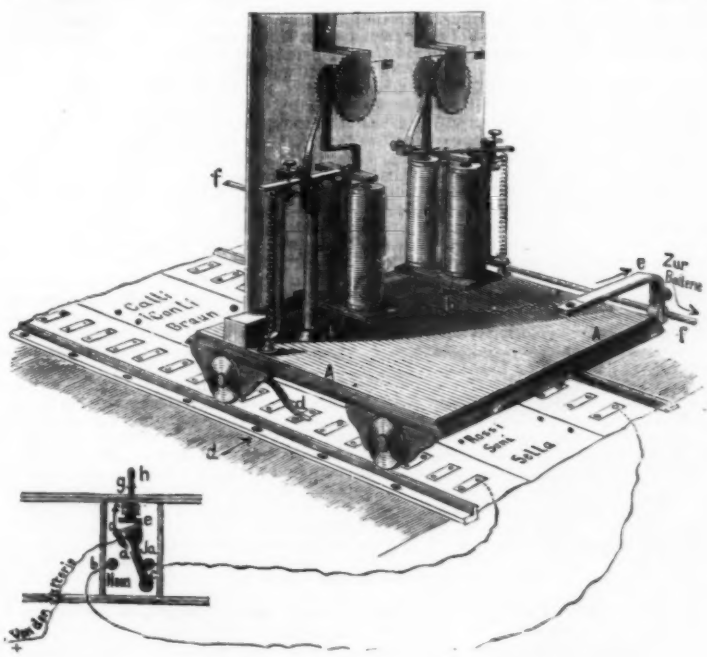


FIG. 2.—ELECTRIC VOTING MACHINE.

HAY FEVER.

THE American hegira is about to begin. The hay-fever patients, falsely so called, for they do not make a sign until the hay is all cut and gathered into barns, have the floor next week—of the railway cars. They have been in town, or at the shore, or out in the open country hitherto, but at this moment they are scanning the Pennsylvania Railroad's excursion-book with a view to rapid transit. By their handkerchiefs you shall know them, these fanatics. Not that they wear them bound upon their arms after the fashion of the Huguenot in Millais's picture—they couldn't spare them long enough for any such sign. They are recommended, indeed, to tie up their faces tight in the cambric, or to breathe only through damp mosquito netting bound across the face like a burglar's mask, but comparatively few of them go about in any such disguise. They are anything but a secret society, although it has been whispered that the sneeze is the grip and pass-word, and that they are a political or a religious body, that takes this chance to get away to the White Mountains for its annual meetings, come what will. The haste that they make to the Waumbek House and other favored rendezvous must be the only reason that the world is not astonished on the 20th of August by a mighty sneeze. We all know what happened when the inhabitants of the planet undertook to cry out on a certain day and hour, and when stunning results were expected. Everybody listened to hear all the rest, and the result was that you might have heard a pin drop. But the autumnal catarrh cannot be smothered, and that is one reason why its victims hurry to put themselves out of hearing among the mountains—where they say all sneezing stops.

Dr. Morrill Wyman, of Cambridge, Mass., has taken his fellow-sufferers into confidence in his book, "Autumnal Catarrh," with a vast array of facts and experiences on the subject, from the confessions of Daniel Webster, Mr. Beecher, and other less noted persons, down to his own observations. He passes by the homœopathic theory that a hair of the dog that bit you—or a decoction, in high potency, of the particular flower, dust, weed, or corn pollen, buckwheat blossom or peach fuzz, that has affected you, will cure—a fancy which has some support, we believe, from experiments on the rose-cold, which comes in June, and is a distinct affair. There is no use in trying to pin the hay fever or autumnal catarrh down to facts. It refuses to be registered as due to any one particular thing. The Roman wormwood, bitter sweet, less euphoniously hog-wood and rag-weed, has been taxed with it. But when this exasperating plant, naturally due in late August, is forced to bloom ahead of time, and is presented to the future sufferers, it might as well be a damp towel for all effect that it has to irritate their sensitive membranes. It may be the season and the blossom, but it takes that particular conjunction of August and vegetation to bring it about.

There are enough sufferers with their sympathizing friends to render the so-called hay fever tolerably familiar in its whole course of wretched symptoms, when the eyes and the nose, and the whole inside of the head and throat are given over to intense discomfort and irritation. Sunlight and dust, a dry wind, the jarring of the train, the smoke of cities, grain fields, the fruit market, the flower bed and caterpillars, are all so many stings and arrows of outrageous mockery, chestnuts and buckwheat cakes alike poison. The oppression, the cough, the headaches, the asthma, are all written out in Dr. Wyman's book. "Eating becomes a matter of skill. You cannot eat and breathe at the same time, but must shut off alternately bread and breath," is the testimony of a distinguished expert.

But there are some very curious tricks in the symptoms. It has never been known to attack a victim before a public audience, observers say. It is relieved by jumping. This may be—who knows—the original motive of the dancing dervishes, as quite a good many American dervishes seem to suffer from it. But it has never yet been traced to the dust of the writing table, although from the intellectual pursuits of most of the distinguished sufferers it appears to be like pen palsy, inherent on this class.

The maps in Wyman's book are interesting. From Eastport, Maine, to North Carolina and Tennessee, are the bad lands, reaching west to the Mississippi. Unhappy Memphis is just at the vanishing corner south—to have hay and yellow fever both is too much for any one latitude. The Alleghanies, from the Juniata south, are exempt, so too are some places by the seaside; and a little belt in the Adirondack and White Mountain region. All the West is free, and all the South, except a few scattered spots, such as Beaufort, S. C., and St. Augustine. But Denver has a mark against it, of all places. But it does not seem to go by the ordinary rules of elevation at all. The Berkshire hills, 1,200 feet above the sea, are no insurance, while Gorham, at only 800 feet, is high above suspicion.

There are other suspicious circumstances. Europe does not know it. A trip abroad furnishes immunity for most. (So does an East wind, at home, relieve while it lasts, but of that, as is natural, not much account is made.) That in the officer is a dreadful attack, that in the common soldier amounts to nothing more than a common cold. Degrading to the ranks will cure it, or enlistment—active *bodily* work for daily bread drives it literally out of the sufferer's head. And yet, with their natural perversity, women refuse to have it in anything like the proportion that men do, so that the theory of exquisite sensitiveness of the nervous system does not seem to be sustained. It is a very odd disease, no doubt, but nobody ever heard of its attacking a poor man, a tramp, or an impecunious person of any description. The mountains, especially the White Mountains, are a cure while the sufferer stays, which in a way remotely connects its strange symptoms with money in the purse. But if he leaves it he goes down hill in a double sense, and has to take the next train back again with weeping eyes.

But as it is true to the calendar to come in, it knows when to go. The first frost is its signal. After that the quarantine is up. The sneezing, gasping, blinded land can come down from the hill tops and mingle with their fellows on a level again. But it is certainly a superior sort of disease, tending to pride of heart, that takes on such high airs while it lasts.—*Philadelphia Ledger.*

ABSTRACTS OF CHEMICAL PAPERS.—JOURNAL OF THE CHEMICAL SOCIETY.

Pressures Produced by Galvanic Deposits. By BOUTY (*Compt. Rend.*, 88, 714–716).—The paper relates to the fact observed by Mills (*Proc. Roy. Soc.*, 26, 504) of the contraction of the bulb of a thermometer when coated electrolytically with a deposit of metal. Mills has stated that the deposit of zinc and that of cadmium are exceptional in causing a dilatation of the bulb instead of a contraction; but the author finds that deposits of these metals act like the rest in exercising a pressure. A theoretical formula given in the paper expresses the pressure on a cylindrical reservoir in terms of its compressibility, radius, etc., and of the coefficient of compressibility of the deposited metal. This coefficient, as determined from the contractions observed in a series of experiments, has for copper the value ·00 001235, while Regnault found directly for red copper ·000001817. The theoretical maximum pressure for an absolutely resisting cylinder would be about 350 atmospheres for a deposit of copper: the greatest pressure actually observed was about 100 atmospheres. A bulb of a very flattened elliptical section would be subjected to pressures increasing so rapidly at the extremities of the major axis that its shape would tend to become circular, and the mercury would sink in the stem. R. R.

Magnetic Rotatory Power of Gases at Ordinary Temperature and Pressure. By H. BECQUEREL (*Comp. Rend.*, 88, 709–712).—The apparatus employed for the experiments described in this paper consisted of a copper tube, 3 meters long and 12 cm. in diameter, having its end closed by glass plates with parallel faces. The tube was mounted horizontally and surrounded by a very large coil, composed of six sections, each containing 15 kilos of copper wire 3 mm. in diameter. The current from a battery of 60 nitric acid cells circulated through the coil to render the interior of the tube a magnetic field. A lime light was the source of light, and by means of plane mirrors of silvered glass the rays were reflected and made to traverse the tube nine times successively, making the effect equivalent to a passage through a gaseous atmosphere 27 meters in length. Reversal of the direction of the current permitted the double rotation of a polarized ray to be measured. Coal-gas at ordinary temperature and pressure gave to polarized yellow light a double rotation of + 6·8 for the 27 meters traversed. This rotatory power accords nearly with that deduced from a theoretical formula, $n_2 (n_2 - 1)$, in which n is the index of refraction. With the vapor of carbon bisulphide, as well as with coal gas, the author was able to verify the fact of the unequal rotation of the planes of polarization of rays of different colors.

Oxygen gas, like other strongly-magnetic substances, exhibited a negative rotatory power; but at ordinary temperatures and pressures the amount was too small to admit of accurate estimation. The author has before shown (*Compt. Rend.*, 83, 1227) that the negative rotations do not vary for rays of different wave-lengths in the same way as the positive do. R. R.

Magnetic Rotatory Power of Vapors. By E. BICHAT (*Compt. Rend.*, 88, 712).—The apparatus used in the author's researches comprised two concentric brass tubes, 3·6 meters long. The inner tube was closed at the end by plates of

glass, and in the annular space between the tubes a current of hot water, hot oil, or steam, was made to circulate. The electric current was furnished by a battery of 80 large Bunsen cells. The rotation of the plane of polarization produced by the same current was observed from zero to the boiling point of carbon bisulphide, and that of tin chloride, $SnCl_4$. The results showed that the molecular rotatory power was maintained until the temperature rose nearly to the boiling point of the liquid. After this a diminution occurs, much more rapid than could be foreseen from considerations based on the relations of the densities. The author hopes, however, to be able ultimately to improve the methods employed, so as to ascertain if there is an invariable relation between the magnetic rotatory power of a liquid and that of its vapor. R. R.

Electrolysis of Water. By F. EXNER (*Ann. Phys. Chem.* [2], 6, 336–353), *and Galvanic Polarization.* By F. EXNER (*Ann. Phys. Chem.* [2], 6, 353–384).—The object of the experiments recorded in the first of these papers is to prove that the electrolytic decomposition of water takes place whenever the electro-motive force of the primary current exceeds in the smallest degree the electro-motive force of the simultaneously developed polarization. In his experiments the author used electrodes of the finest platinum wire, and these were viewed through a lens, in order that the first indications of the extrication of gas might be observed. The primary current was derived from a thermopile, so arranged that the electro-motive force could be gradually increased by bringing more and more elements into the circuit. The electro motive forces of the primary and polarization currents were measured by methods described in *Ann. Phys. Chem.*, 6, 338. Up to about 2·00 Daniell cells, the primary current developed a polarization electro-motive force equal to its own. When the primary current was equal to 2·30 Daniell, the polarization current was equivalent to 2·03 Daniell, and at this value it remained constant, notwithstanding the further increase of the primary current. The decomposition was first observed at this point, namely, when the primary current had an electro-motive force exceeding that of the polarization current by 0·27 Daniell. These were the results with pure water free from dissolved gases: the effects of adding a few drops of sulphuric acid were that the decomposition commenced with a somewhat weaker primary current, and the excess of its electro-motive force over that of polarization was now only 0·09 Daniell. With electrodes of copper immersed in dilute sulphuric acid decomposition first took place with a primary equal to only 0·54 Daniell, and exceeding the polarization current by only 0·03 Daniell. Similar experiments with other metals led to the conclusion that an effective electro-motive force of less than 0·03 Daniell suffices to decompose water. A general law of electrolysis is derived from the discussion of these experiments, namely, that in any closed circuit, of which an electrolyte forms a part, the electrolyte is decomposed as soon as an effective electro-motive force, however small, predominates throughout the general circuit.

The researches described in the second paper have for their object to prove that there is no essential difference between a polarization element and an ordinary one. The source of the current is, in the latter, the oxidation of zinc; in the former it is the oxidation of hydrogen. The paper gives in detail the numerical results of experiments with different substances, the experiments forming 29 series. The correctness of the author's conclusion is exemplified by a table showing the close correspondence of the calculated and the observed electro-motive forces of polarization currents in 24 cases where different electrolytes and electrodes were employed. The discussion of the results includes some observations on the theories of electrolysis and related subjects. R. R.

Galvanic Polarization of Platinum in Water. By F. EXNER (*Ann. Phys. Chem.* [2], 5, 388–405).—The different values which observers have found for the maximum polarization of platinum in the electrolysis of water led the author to investigate the circumstances which may have caused these differences, and to inquire in what way the electro-motive force of the polarization current increases when that of the primary current increases from 0 to a point beyond the maximum of the polarization.

A quadrant electrometer was used to measure the electro-motive force both of the battery and of the voltameter, that of the battery being first found. The battery was connected with the voltameter for a time, and then, by means of a switch, the battery was instantaneously thrown out and the electrodes connected with the quadrants of the electrometer. Two circumstances were found to have very great influence: First, electrolytic conduction, in which the hydrogen set free recombines with the oxygen already dissolved in the water. This only causes a redistribution of the oxygen as far as it occurs, and the polarization of the electrodes is always less than that of the primary current. The extent to which it takes place depends on the shape of the electrodes, and is least when they have the least surface, as the gas is then evolved too quickly to combine with the oxygen. It may be almost entirely obviated by employing fine platinum wires. It also disappears when the water is free from gas. In this case the electro-motive force of the polarization is always equal to that of the primary current up to its maximum, which, however, varies with the second modifying circumstance, the formation of hydrogen peroxide by a secondary action. The conditions of the experiment have a very great influence on this; for instance, the higher the temperature the less the amount formed, and the lower the maximum polarization. J. H. P.

Preparation of Anhydrous Sodium Sulphate from Glauber Salt.—By A. R. PECHINEY (*Chem. Centr.* [3], 1878, 816).—If Glauber salt solution is heated above 33° C. there separates gradually as much as 40 per cent. of the anhydrous salt. Balard has further shown that if to the solution of Glauber salt another soluble salt is added which contains the same metal or acid radical, the salt is also separated. These facts are utilized as follows. The Glauber salt is dissolved by stirring it in water heated by steam to 40–50°, then magnesium sulphate or sodium chloride, or both, are added. When the salt has separated it is filtered off, or separated by a centrifugal machine. With 16 to 20 parts of sodium chloride and 100 of Glauber salt about 90 per cent. of the anhydrous salt is separated. With 45 parts of "salinen salt" (45 parts of sodium chloride mixed with 50 of magnesium sulphate) to 100 of Glauber salt, the whole of the anhydrous sodium sulphate is separated. F. C.

Ultramarine.—By E. W. BUCHNER (*Deut. Chem. Ges. Ber.*, 12, 234–235).—Ultramarine blue can be prepared by heating a mixture of sodium, aluminum, and silicon to a high temperature in a stream of sulphureted hydrogen, washing the resulting black mass with water, and strongly igniting it in contact with air. The author asserts that metallic sulphides are not contained in ultramarine, for the above black mass, in which no blue can be discerned with a high power, gives blue particles visible to the naked eye when ignited either in air, in oxygen, or with potassium chlorate. Ch. B.

Constitution of Coal.—By E. GUIGNET (*Compt. rend.*, 88, 590–592).—Many chemists have succeeded in dissolving out small quantities of bituminous matter from coal by means of ether, benzene, carbon bisulphide, and chloroform. The author has obtained better results with phenol.

The coal, dried at 110°, and reduced to the finest possible state of subdivision by grinding with water until it assumes a clear brown color and is quite soft to the touch, yields as much as 4 per cent. of its weight to dry boiling phenol. The filtrate is brown, and on the addition of alcohol deposits the dissolved matter in brown flocks, which are thrown on a filter and washed with alcohol until free from phenol. Nitric acid attacks this substance with some difficulty, forming a yellow product. On repeatedly treating the original coal with nitric acid, filtering, evaporating the filtrate to dryness, taking up with water, boiling with barium carbonate, filtering, and precipitating the barium in the filtrate by sulphuric acid, a solution is obtained containing *trinitroresorcinol* (oxypicric acid). The barium carbonate precipitate contains barium *oxalate*, besides barium sulphate and ferric hydrate. The coal residue insoluble in nitric acid contains nitro products similar to the nitro-cellulose, and on heating decomposes with explosion or evolutions of red fumes; it also contains products giving a brown solution with sodium hydrate and even with ammonia.

The original coal, evaporated to dryness with strong caustic soda, and distilled at 400° in an iron retort yields a clear yellowish liquid containing among other things ammonia and aniline, but no *resorcinol*. The distillation residue treated with water gives a deep brown solution, which, neutralized with an acid, deposits a large quantity of brown substance resembling the ill-defined compounds confounded under the names *ulmin*, *humic acid*, etc. By treating the coal with concentrated or fuming sulphuric acid, or nitro-sulphuric acid, similar products are obtained, in the latter case mixed with nitro-products. J. M. H. M.

Presence of Nitrils in the Distillate obtained by the Calcination of Residues from Beet-root Molasses.—By C. VINCENT (*Bull. Soc. Chim.* [2], 31, 156–157).—Impure methyl alcohol holding in solution various nitrils constitutes the principal product obtained by the destructive distillation of the "vinasses," or residues from the fermentation of beet-root molasses. After neutralization and rectification, this distillate was boiled with milk of lime for 30 hours, or as long as ammonia was evolved, in order to decompose the nitrils, and to obtain from them the corresponding acids; the latter having been converted into soda salts, were crystallized and the sodium acetate, which was most abundant, separated as far as possible. The mother liquors were treated with alcohol and sulphuric acid to etherify the acids, and the compound ethers were separated by fractional distillation; from these the acids were recovered by saponification. In this manner propionic acid boiling at 141·6°, butyric acid boiling at 163–164°, and valeric acid at about 175° were isolated, thereby proving the existence in the original distillate of the cyanides of ethyl, normal propyl, and isobutyl. J. W.

FILTERING AND PURIFYING OF WATER.

WOOD charcoal possesses, in a greater measure than all other cheap substances, the property of condensing oxygen. It is largely superior even to animal charcoal in this respect, supposing equal weight of the two materials to be compared. And yet animal charcoal is universally admitted to be the best filtering medium available for practical purposes. This admission, however, is more theoretical than practical. We do not often find that filters are constructed with animal charcoal only as the filtering agent. There are many methods in common use whereby wood and animal charcoal are employed in combination for filtering purposes. Sometimes the wood charcoal is used in its original condition, but more often it is broken into small pieces and then made up into blocks of a convenient size by the aid of some inert material which serves to hold the particles together in the required shape.

On the other hand, no experienced filter maker ever trusts to wood charcoal alone. There is a great difference in the nature and action of the two substances, and the fact is not surprising, when we remember that animal charcoal consists chiefly of "phosphate of lime," whereas wood charcoal is mostly carbon.* The fact is, that animal charcoal (made from bones) is not only a strainer and oxidizer in combination, it is also a "precipitant;" it has the power of precipitating from water certain forms of organic matter which could not be so readily removed as some others by oxidation alone. It may also precipitate certain forms of inorganic matter, but with this we are less concerned at present. The organic matter which animal charcoal separates from water by precipitation is just that which shows most, and yet is least dangerous; it is chiefly coloring matter; and it is remarkable that animal charcoal retains the power of removing coloring matter from water for a long time after its power of removing the more dangerous forms of organic matter by oxidation is quite exhausted.

The coloring matter thus removed from water is retained in the filter itself, probably in combination with the lime, from which it can again be separated by the use of boiling caustic alkalies. In this way the original filtering power of the animal charcoal can be in a great measure revivified.

From these facts it will easily be seen why the use of animal charcoal alone as a filtering agent may be particularly dangerous, especially in the hands of inexperienced persons. These things also point us to the conclusion that water filters for ordinary purposes should be so arranged that the water may be submitted to the action of animal charcoal first, and wood charcoal afterward. Filters of widely various design, and working on very diverse principles, are often to be found in commerce. Perhaps they are all good and useful with proper treatment, but they all require attention. The filtered and unfiltered waters should be tested and compared periodically, in order that any sensible variation in the action of the filter may be made apparent. For this reason, too, it is advisable never to use a store tank in connection with a filter. Let the filter be of a capacity sufficient to supply water as fast as it may be required at any moment, and always let the filtered water be drawn directly from the filter. By this means all possibility of after-pollution will be avoided, and in the majority of cases the filter itself will call imperatively for attention as soon as it is needed, by withholding the necessary supply.

* The chemical composition of "bone black," or ordinary "animal charcoal" prepared from bones, is as follows:

Carbon	14 per cent.
Calcium phosphate	80 "
Calcium carbonate	5 "

We must not here discuss the merits or advantages of the special forms of filter supplied by various manufacturers, because, however impartially we might conduct the inquiry, we could not expect to make our impartiality evident to interested parties, but we may perhaps refer to two facts of general interest without offense to any one, namely, 1st, high pressure filters, as a rule, are precarious in action; 2d, "self-cleansing" filters are not precisely what the name seems to imply.

The high pressure filter may do useful work as a strainer, but there are two reasons why it cannot safely be depended upon to effect the complete purification of water:

1st. Regularity of action in any filter is in inverse proportion to the pressure of the liquid; as the pressure increases, the action becomes more and more uneven, the finer parts of the structure becoming ruptured successively, until the whole apparatus is reduced to a system of minute channels, through which all impurities below a certain caliber may freely pass. Meantime the less yielding parts are gradually being stored with impurities, which agglomerate and stick together in security, and eventually become the happy homes of myriads of animalcula.

2d. In consequence of the free passage of water through the filter produced by high pressure, the timely warning of impeded action is not in this case available.

"Self-cleansing," as applied to filters, is somewhat of a misnomer. The method usually relied upon for what is called self-cleansing, is to reverse the flow of water occasionally, admitting it by the usual outlet of the filter, and expelling it by the usual inlet. By this means we are asked to expect that the accumulations of weeks or months can be swilled out in a few minutes. To a certain extent the theory is true, and so far as it is true, the practice is advantageous. It is clear that the great bulk of coarser impurities which have never penetrated the structure of the filter can be swilled away at once, and thus the filter will be relieved of a strain which, if unchecked, would increase disastrously.

But the finer particles which have for months been going through the process of being fitted to their lodgings are not so easily disposed of. Where very impure water is acted upon, all visible impurities may be washed away by the "self-cleansing" process, but if after a certain time the filter be taken apart, the sense of smell will reveal the fact that its power of purification has become exhausted, and the power of pollution has grown up in its place. Of course, these statements are equally applicable to ordinary filters, but the term "self-cleansing" is apt to lead us to expect results which, as yet, are only partially attainable.

We have already alluded very briefly to the use of permanganic acid and its salts for purifying water. It may be advisable here to add a few words on the value of these and other preparations possessing somewhat similar properties, as accessories in connection with various methods of filtration.

The value of substances of this class as purifying agents depends upon their power of readily oxidizing organic bodies, and of producing harmless residues as the ultimate results of the reaction. The residues from the manganates and permangates of soda and potash are oxide of manganese and carbonate of soda or potash, as the case may be, together with water and carbon dioxide, the chief products of combustion of the organic matter. Of these the oxide of manganese is an insoluble brown powder, very much resembling oxide of iron or common "rust" in appearance, and having similar tonic properties as a therapeutic agent. The harmless properties of the other products are familiar to every one.

The oxidizing power of permanganate of potash is very strikingly exemplified by reducing a small quantity of the substance to fine powder in a mortar, and mixing it with an equal quantity of finely powdered tartaric acid. In a few minutes the mixture will burst into a flame spontaneously.

When the water to be filtered contains a large quantity of organic matter in solution, it will prove an immense help to the filter to add a small quantity of permanganate to the water before filtering. By "permanganate," we mean permanganate of potassium, unless otherwise specified; and a small quantity, in this application, means, in the majority of cases, something less than half a grain per gallon. This quantity will be quite sufficient to give a beautiful purple tint to the water, and this tint will be permanent or fleeting according as the water is pure or otherwise.

There is one important precaution to be observed in the use of permanganate as an accessory to the filter, namely, the filter and tank should contain no organic fittings of any kind—no wood, no felt, no flannel; the two latter substances would deoxidize the permanganate with extreme rapidity, and thus prevent its useful action on the impurities contained in the water.

If a felt or flannel strainer be used in conjunction with the filter, the water should be treated with permanganate in a separate tank before filtering, and it should not be passed into the filter tank until the purple tint has almost disappeared. But, as pointed out by one of our correspondents a few months since, the permanganate solution affords a very convenient means of purifying the filter itself. When this is to be done, a stronger solution may be made use of, and it should be kept flowing through the filter until the purple tint remains permanent in the out-flowing stream, In a general way, however, it is better to use the permanganate in a separate tank, because it prevents an unnecessary choking of the filter by the deposit of manganic oxide. These are exceedingly important applications of the permanganates, and no aerated water manufacturer who understands their value will ever omit them from his stock.

Valuable as are the permanganates, however, for the purposes referred to, there is another salt—scarcely yet known to the scientific world, and certainly not known to one shop chemist in a thousand—which in many ways is still more suitable for similar purposes. We refer to calcium iodate. About seven or eight years ago, Mr. Edward Sonstadt, F.C.S., prepared considerable quantities of this remarkable substance from the residuum which remained after extracting potassium iodide from sea-weed. Several articles describing the properties and uses of the iodate were published by Mr. Sonstadt in the *Chemical News* of that period, and samples were offered to chemists at 1s. 6d. per ounce. We fortunately secured some of Mr. Sonstadt's samples, and were highly pleased to be able to verify the novel and useful properties that had been pointed out; but a sample which we afterward obtained from a London manufacturing chemist, at 5s. per ounce, was much inferior in many respects.

Iodate of calcium, when properly prepared, is a white, crystalline powder, almost insoluble, and having a very faintly acid taste. Its oxidizing powers are very great, but instead of acting upon all organic substances indiscriminately, it seems to attack the most unstable compounds first. —*Mineral Water Review.*